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PPRD East 2

Regional Guidelines on Flood Risk Management

April 2016

Programme funded by the European Union

and implemented by a consortium led by MWH

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MWH

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Abbreviations

BMO	Basin Management Objective, Armenia
BUWR	Basin Administrations for Water Resources, Ukraine
CJSC	Close Joint Stock Company
CMC	Crisis Management Centre of MES, Azerbaijan
CoE	Council of Europe
CoM	Cabinet of Ministries
CORINE	CORINE Land Cover (CLC) is a geographic land cover/land use database
CP	Civil Protection
CPESS	Civil Protection and Emergency Situations, Moldova
CRICUWR	Central Research Institute for Complex Use of Water Resources of Ministry of Natural Resources and Environmental Protection of Belarus Republic
DEM	Digital Elevation Model
DEMP	Disaster Emergency Management Plans
DLD	Disaster Loss Data
DM	Disaster Management
DRA	Disaster Risk Assessment
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
EaP	Eastern Partnership
EEA	European Environment Agency
Eionet	European Environment Information and Observation Network
EMA	Emergency Management Agency, Georgia
ENPI	European Neighbourhood and Partnership Instrument
EPIRB	Regional EU funded project for Environmental Protection of International River Basins
ERRA	Electronic Regional Risk Atlas
EU	European Union
EUFD	EU Floods Directive
EWS	Early Warning Sysytem
EXZECO	Code d'EXctraction des Zones d'ECOulement method, France
FHRA	Flood Hazard and Risk Assessment
FRMP	Flood Risk Management Plan
GIS	Geographic Information System
GTZ	German Technical Cooperation Agency

INSPIRE	Infrastructure for Spatial Information in the European Community
ISO	International Organization for Standardization
IT	Information Technology
IWRM	Integrated Water Resources Management
JRC	Joint Research Centre EU
JSC	Joint Stock Company
LRWM	Committee of Land Reclamation and Water Resources, Azerbaijan
MENR	Ministry of Ecology and Natural Resources, Ukraine
MENR	Ministry of Ecology and Natural Resource, Azerbaijan
MENRP	Ministry of Environment and Natural Resources Protection, Georgia
MES	Ministry of Emergency Situations
MNP	Ministry of Nature Protection, Armenia
MoA	Ministry of Agriculture
MoF	Ministry of Finance
MoH	Ministry of Health
MoIA	Ministry of Internal Affairs, Moldova
MoNREP	Ministry of Natural Resources and Environmental Protection, Belarus
MSs	EU Member States
MTAES	Ministry of Territorial Administration and Emergency Situations, Armenia
MTEF	Mid-Term Expenditure Framework, Georgia
MATTM	Ministry of Environment, Land and Sea Protection
NAG	National Advisory Group
NAoS	National Academy of Science
NAS IGS	Armenian National Academy of Sciences, Institute of Geological Sciences, Armenia
NGO	Non-Governmental Organisation
NSDP	National Sustainable Development Plan, Georgia
NUTS	Nomenclature of Territorial Units for Statistics
OJSC	Open Joint Stock Company
PFP	Partnership for Peace
PFRA	Preliminary Flood Risk Assessment
PMF	Probable Maximum Flood
PPP	Public-private partnership
PPRD East 1 Programme	EU-funded Programme for the Prevention, Preparedness and Response to Man-made and Natural Disasters in the ENPI East Region, Phase 1
PPRD East 2 Programme	EU-funded Programme for Prevention, Preparedness and Response to Natural and Man-made Disaster in EaP Countries, Phase 2

PRA	Preliminary Risk Assessment
PuP	Public-public partnership
RBMP	River Basin Management Plan
SAWR	State Agency of Water Resources, Ukraine
SCWE	State Committee of Water Economy, Armenia
SES	State Emergency Service, Ukraine
SHS	State Hydro-Meteorological Service, Moldova
SSCMC	State Security and Crisis Management Council, Georgia
SWRA	State Water Resource Agency, Azerbaijan
UHMC	Ukrainian Hydro-Meteorological Centre
UHMI	Ukrainian Hydro-Meteorological Institute
UN	United Nations
UNDP	United Nation Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNISDR	United Nation International Strategy for Disaster Risk Reduction
UoM	Unit of Management
USAID	United States Agency for International Development
WFD	Water Framework Directive
WHO	World Health Organisation
WISE	Water Information System for Europe
WMO	World Meteorological Organisation
WRMA	Water Resources Management Agency, Armenia

1. Executive Summary

The aim of this document is to provide guidelines and references for approaching the implementation of the EU Floods Directive 2007/60/EC[1] for PPRD East2 six partner countries: Azerbaijan, Armenia, Belarus, Georgia, Moldova and Ukraine. In particular, the operational description of the different phases of the EU Floods Directive are reported and shown with the aid of some experiences of European Community Member States. These Guidelines are related to Activity area A.1 of PPRD East2 programme capacity building for the implementation of the EU Floods Directive and for addressing flood prevention. The document also summarizes the current status of practices in the area of flood risk management and the approximation to the EU Floods Directive (EUFD) in six partner countries as better described in the county profiles.

Essentially, the following documentation was used for preparation this Guidelines:

- Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks, 2007;
- IPA Floods Guidelines for the implementation of EU Floods Directive and MSs Good Practices, 2016;
- EU Overview Assessment of Member States' reports on Preliminary Flood Risk Assessment and Identification of Areas of Potentially Significant Flood Risk, 2015;
- EU Overview of methodologies used in preparation of Flood Hazard and Flood Risk Maps, 2015;
- PPRD East1 Risk/Hazard Assessment Policy for the ENPI Eastern Region, 2012;
- WMO Formulating a Basin Flood Management Plan: A Tool for Integrated Flood Management, 2007

SECTION 1
Executive Summary
SECTION 2
An Introduction and short description of Floods Directive 2007/60/EC (EUFD).

SECTION 3

The main steps for implementation of EU Floods Directive. The concepts of Units of Management and Institutional framework are explained on example of EU Member States.

SECTION 4

An overview of Flood Risk Management legislation, Units of Management and Institutional Framework in Partner Countries is given, developed on the basis of Country Profiles.

SECTION 5

Scope and objectives of EUFD first step - Preliminary Flood Risk Assessment (PFRA). PFRA from European perspective and current status of PFRA in Partner Countries is presented in this section. The operational phases of PFRA based on EUFD methodology are provided; and PPRD East 1 Risk/Hazard Assessment Policy concepts on preliminary assessments are overviewed.

SECTION 6

[1] (EU Floods Directive Requirements at link http://ec.europa.eu/environment/water/flood_risk/implem.htm)

The Flood Hazard Risk Assessment and Mapping (FHRM) is explained on the basis of EUFD as well as the EU methodologies for its implementation and Good examples of EU Member States Germany, Ireland and Italy on its implementation. The current status of FHRM in Partner Countries is provided. Some general notes based on PPRD East 1 Risk/Hazard Assessment Policy are considered in the framework of FHRM.

SECTION 7

This section is dedicated to the Flood Risk Management Plan methodology in European perspective. An overview of current status of Flood Risk Management Plan in Partner Countries is given. WMO approach on Flood Risk Management Plan and Regional Risk Management Process proposed by PPRD East 1 project is overlooked. General guidance for the preparation of Flood Risk Management Plan is provided.

SECTION 8

Conclusions on Preliminary Flood Risk Assessment, Flood Hazard and Risk Mapping and Flood Risk Management Plan established by EU Floods Directive. The overview of current status on Flood Risk Management Plan and Risk Management Process is provided of PPRD East2 Partner Countries.WMO approach and PPRD East 1 project findings are presented, in order to give a wider spectrum of references to the beneficiaries of this document.

SECTION 9

References

All sources are listed in the reference section.

Annex

The Annex section provides a catalogue of Flood types according to the EU Floods Directive terminology.

2. Introduction

From 26 November 2007 the Floods Directive 2007/60/EC[2] on the assessment and management of flood risks entered into force.

This Directive obliges EU Member States:
a) to make assessment of all water courses and coast lines on risk from flooding;
b) it requires to map the flood extent and assets and humans at risk in these areas;
c) and to take adequate and coordinated measures to reduce this flood risk.
Floods Directive ensures also the rights of the citizens to have access to this information and engagement in the risk planning process.

The Floods Directive have a three-stage implementation process, with output of Flood Risk Management Plans to be established by 2015 in coordination with the Water Framework Directive 2000/60/EC.
The Member States, Norway and the EU have designed a Common Implementation Strategy (CIS) for the Water Framework Directive (WFD) in a co-operative and coordinated way. in addition to the CIS a Working Group on Floods (WG F) has been set up to support the implementation of the Floods Directive, and provide a platform for information exchange on flood risk management at EU level.

The following table details the milestones for the EUFD implementation:

Issue	Deadline	Reference
Entry into force	26.11.2007	OJ L 288, 6.11.2007 Art 18
Transposition	26.11.2009	Art 17
Reporting format Preliminary Flood Risk Assessment	22.12.2009	Art 11
Administrative arrangements to be in place and to be notified to the Commission	26.5.2010	Art 3
Cut-off date transitional measure (availability of existing tools)	22.12.2010	Art 13
Preliminary flood risk assessment	22.12.2011	Art 4 & 5
Public participation process starts (publication of mechanism and timetable for consultation)	22.12.20123	Art 9.3 & 10
Flood hazard and risk maps	22.12.20134	Art 6
Flood risk management plans	22.12.20155	Art 7
2nd Preliminary Flood Risk Assessment, specific requirement on climate change Commission's first implementation report due.	22.12.2018	Art 14.1 & 4

[2] (Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks at link http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32007L0060&from=EN)
[3] coordination with article 14 (WFD) requirements
[4] date of 1st review of pressure and impact analysis under the WFD
[5] date of 1st review of WFD river basin management plans

2nd Flood hazard and risk maps	22.12.2019	Art 14.2
End of 1st flood risk management cycle 2nd Flood Risk Management Plans, specific requirement on climate change. 3rd Water Framework Directive River Basin Management Plans.	22.12.2021	Art 14.3 & 4

With a Review /update every 6 years thereafter and Reporting to the Commission: 3 months after.

The mandate (Mandate Working Group F "Floods" 2016-2018[6], 2015) of WG F describes objectives, tasks, deliverables, structure and organization of working group. The objective of the work programme is to promote the information exchange among Member States and other CIS Working Groups, and support coordination, integration and interplay of WFD and FD.

Among main objectives of WG F are:

- "information exchange among Member States, the EU Commission and stakeholders on good practices, policy, research and project developments and new approaches to enhance flood risk management in Europe,
- feedback on the implementation of the EUFD and its reporting with a view to reaching a common understanding on the requirements for the implementation of the EUFD and efficient and effective reporting,
- linking with related activities of the CIS at EU level, and with other Commission or international activities for support of the implementation."

The tasks of WG F envisage regular 6-monthly meetings, a number of thematic workshops, review and amendment of relative documentation, input into other CIS and EU-Level activities (research, Risk assessment and management and civil protection activities lead by DG ECHO Civil Protection and EU Climate Change Adaptation Strategy), introduction of a voluntary peer review process.

The official key documentation is provided on the European Commission web-site at links:

- on Floods Directive 2007/60/EC
  http://ec.europa.eu/environment/water/flood_risk/key_docs.htm
- on Water Framework Directive 2000/60/EC
  http://ec.europa.eu/environment/water/water-framework/index_en.html

PPRD EAST 2 partner countries have various Flood Management practices at national level. Some of them have already developed Flood Management Plans in the framework of various international cooperation projects. But often these initiatives are designed for limited areas or particular basins and are not necessarily compliant to the Floods Directive. A revision of current status of Flood Management practices of partner countries will help to further improve existing methods and development of procedures for the approximation to the Floods Directive 2007/60/EC.

[6] (Mandate WG F at link:
https://circabc.europa.eu/webdav/CircaBC/env/wfd/Library/floods_programme_1/b_wg_f_on_floods/18th%20meeting%20-%2022-23_10_2015/Documents/WG_Floods_Draft%20Mandate%202016_18%20v.1.1.pdf)

3. Legal and Institutional Framework on Flood Risk Management in Europe: the EU Floods Directive

This section gives an introduction to EU Floods Directive and describes its aim and main steps of implementation. The overview of legal framework of Flood Risk Management in PPRD East 2 six partner countries is also provided based on last updated (2015) Country Profile reports.

3.1 Main Requirements of EU Floods Directive

The European Floods Directive (EUFD) has aim to[7]:

- establish a framework for the assessment and management of flood risks, aiming at the reduction of the adverse consequences for human health, the environment, cultural heritage and economic activity associated with floods in the Community;
- establish a process for producing flood hazard maps and flood risk maps in order to address the flood risk;
- in the flood risk management plans address all aspects of flood risk management focusing on prevention, protection, preparedness, including flood forecasts and early warning systems and taking into account the characteristics of the particular river basin or sub-basin.

The approach to flood risk management in EU Member States is divided in three main steps, as follows[8]:

1. EU Member States undertake a preliminary flood risk assessment of their river basins and associated coastal zones, to identify areas where potential significant flood risk exists - by 2011.
2. Where real risks of flood damage exist, **flood hazard maps** and **flood risk maps** for such areas must be developed - by 2013. These maps identify areas with a medium likely hood of flooding (at least a 1 in 100 year event) and extreme events or low likelihood events, in which expected water depths are indicated. In the areas identified as being at risk the number of inhabitants potentially at risk, the economic activity and the environmental damage potential are indicated.
3. Finally, flood risk management plans must be drawn up for these zones - by 2015. These plans are to include measures to reduce the probability of flooding and its potential consequences. They will address all phases of the flood risk management cycle but focus particularly on prevention (i.e. preventing damage caused by floods by avoiding construction of houses and industries in present and future flood-prone areas or by adapting future developments to the risk of flooding), protection (by taking measures to reduce the likelihood of floods and/or the impact of floods in a specific location such as restoring flood plains and wetlands) and preparedness (e.g. providing instructions to the public on what to do in the event of flooding). Due to the nature of flooding, much flexibility on objectives and measures are left to the Member States in view of subsidiary.

The scheme below (Figure 1) provides the three phases of EU Floods Directive namely:

- Preliminary Flood Risk Assessment (PFRA)

[7] (EC Technical Report (2014-078) Links between the Floods Directive at link https://circabc.europa.eu/sd/a/2e917bbb-abff-41ac-b6fc-0fc91bf0347d/inks%20between%20the%20Floods%20Directive%20and%20Water%20Framework%20Directive%20-%20Resource%20Document.pdf)

[8] (EU Floods Directive Requirements at link http://ec.europa.eu/environment/water/flood_risk/implem.htm)

- Flood Hazard Maps and Flood Risk Maps (FHM &FRM)
- Flood Risk Management Plans (FRMP)

Figure 1. **Flow chart with EUFD implementation phases**

The above-listed stage process need to be reviewed every 6 years in a cycle coordinated and synchronized with the Water Framework Directive (WFD) implementation cycle. The FD planning cycle is shown in Figure 2.

Figure 2. **The EU Floods Directive planning cycle.**

3.2 Units of Management and Institutional Framework in EU Member States

The EU Floods Directive indicates that Member States may make use of the administrative arrangements made under Article 3 of the Water Framework Directive. However, different competent authorities may be appointed by Member States for the Floods Directive.

River Basin Districts

As defined by the European Commission, "River Basin Districts (RBDs) are the main units for the management of river basins and have been delineated by Member States under Article 3 of the Water Framework Directive (WFD). For the Floods Directive Member States were given the choice to use either the WFD River Basin Districts, or to designate other Units of Management (UoM) for specific river basins

or stretches of coastal areas under article 3 of that Directive. For the majority of RBDs, EU Member States used the same ones as for the WFD. The geographic area of some RBDs span more than one country (such as the Danube) and these are known as International RBDs. Others (the minority) are contained completely within a country and are known as National RBDs."

Units of Management

The UoM consist in boundaries identified to manage rivers and/or certain coastal areas. The definition of the UoM can be based on geomorphological or administrative criteria.

Object as defined in the EUFD:

May be individual river basins and/or certain coastal areas; may be entirely within national borders or may be part of an international Unit of Management or International River Basin District.

The Floods Directive (Article 3.2) allows Member States to identify Units of Management different from the River Basin Districts used for the Water Framework Directive. Competent Authorities will be required for each national RBD or UoM and for the portion of any international RBD or UoM lying within its territory.

The EUFD implementation process needs to start from a complete definition of the command and control chain for Flood Management; mapping of institutions competent in all the aspects of EUFD and understanding potential conflicts with other EU Directives / National plans is a priority and the following aspects have to be analyzed:

- regulatory framework (who, what, when, where, why)
- institutional subdivision of powers (identification of duty holders in the water management and civil protection systems)
- institutions in charge
- inter-institutional relations
- mandate and responsibilities of stakeholders
- international agreements on flood management (bilateral, multilateral, regional)

The analysis should be able to define the framework inside which it is clearly possible to identify who:

- is in charge for coordinating the PFRA;
- has the technical knowledge for managing PFRA data eventually available;
- has the information at local/catchment level.

In theory, the institutions involved in the PFRA can be various, and an appropriate coordination and harmonization of their activities should be done, eventually developing a capacity building phase specifically oriented to this task.

Only afterwards can properly start the implementation of the operational procedures aimed to preliminary assess areas with potential significant flood risk and to develop a chain of studies upon them which will be concluded with the production of proper operative flood management plans.

It has to be underlined that EUFD recommend to widen the analysis with the updated overview of ongoing or completed relevant initiatives regarding the local approximation to EUFD, with attention to be paid on possible synergies.

Object as defined in the EUFD:

Preamble, point 17: Development of river basin management plans under Directive 2000/60/EC and of flood risk management plans under this Directive are elements of integrated river basin management.

The two processes should therefore use the mutual potential for common synergies and benefits, having regard to the environmental objectives of Directive 2000/60/EC, ensuring efficiency and wise use of resources while recognizing that the competent authorities and management units might be different under this Directive and Directive 2000/60/EC.

EU Institutional Framework Detection Scheme

Analysis of institutions that can be appointed for Coordination, Preparation and Production of preliminary flood risk assessment, flood maps and flood risk management plans, including international coordination in transboundary units of management e/o reporting to the EU:

- legal status of each competent authority:
  - the legislation establishing the competent authority
  - the legislation laying down the duties of the competent authority in relation to the Floods Directive
  - the legislation laying down other duties of the competent authority relevant (but not directly related) to the EUFD
- institutional relationships established to ensure co-ordination where the competent authority acts as a co-ordinating body for other competent authorities
- when more than one competent authority is established:
  - list showing the coordinating body and the relationship between the coordinating body and the authorities
  - whose activities it is coordinating, and relationships with other bodies carrying out tasks linked to implementation of the plans including, for example, civil protection agencies and early warning systems
- international relationships: details established to ensure coordination where a river basin district or other unit of management covers the territory of more than one State
- details of any other institution that could perform a relevant role in water management, spatial planning, flood forecasting, flood warning and civil protection, in addition to the scientific community
- details of completed and ongoing initiatives regarding the EUFD.

Institutional framework for EUFD in EU Member States

The European Environment Agency (EEA) is an agency of the European Union. Its role is to provide sound, independent information on the environment. EEA is a major information source for those involved in developing, adopting, implementing and evaluating environmental policy, and also the general public. Currently, the EEA has 33 member countries.

The regulation establishing the EEA was adopted by the European Union in 1990. It came into force in late 1993 immediately after the decision was taken to locate the EEA in Copenhagen. Work started in earnest in 1994. The regulation also established the European Environment Information and Observation Network (Eionet).

EEA's mandate is:

- To help the Community and member countries make informed decisions about improving the environment, integrating environmental considerations into economic policies and moving towards sustainability;
- To coordinate the European environment information and observation network (Eionet).

The European Environment Agency and the European Commission (DG Environment, Joint Research Centre and Eurostat) created the Water Information System for Europe – WISE[9]. The main roles and responsibilities of the EEA's are to hosts the Water Data Centre and the thematic WISE web pages.

The authorities responsible for the implementation of the Floods Directive in all EU Member States are listed in WISE website.

[9] (EEA Floods Directive viewer at link http://www.eea.europa.eu/themes/water/interactive/floods-directive-viewer)

4. Overview of Legal Framework of Flood Risk Management in Partner Countries

In this section is provided an overview of current status of legislation in relation to EU Floods Directive 2007/60/EC in PPRD East2 partner countries.

The Table 1 summarizes the main findings found during NAG meetings 2015 with national experts. Moldova has adapted the water legislation to EUFD standards. Georgia, and Ukraine are close to apply the EUFD to national legislation. Azerbaijan and Armenia are in stage of pacification for transportation and inclusion of Floods Directive principles. The status of EUFD adaptation in Belarus Republic is under consideration.

EaP Countries	EUFD transposed into national legislation	EUFD transposed into association agreement	Plan for transportation of EUFD*	Plan for inclusion of EUFD provision and principles in legislation*
Azerbaijan				**V**
Armenia			**V**	
Belarus			**Under consideration**	
Georgia		**V**		
Moldova	**V**			
Ukraine		**V**		

Table 1. Summary table on status of EUFD in EaP countries

*As it was discussed during NAG meetings (2015) of PPRD East2

ARMENIA

The Republic of Armenia has not yet officially adopted EUFD and therefore it is not included within Armenian legislation. At a national level, a management plan according to all aspects of the EUFD is not available.

Armenia has developed its own Water Code since 1992. A totally updated version, adopted in 2002 and amended later on, regulates many aspects of national water policy, including development of water basin management plans. Article 5, dealing with basic principles of management, use and protection of water resources and water systems. While Article 19 defines the actions needed to establish an effective Water Resources Monitoring and Information System with the aim, among others, of forecasting on floods and mudflows.

EUFD is mainly implemented, in terms of flood hazard and flood risk maps compliant with the prescriptions of the Directive, through international pilot projects and single basin-scale initiatives.

The Law of the Republic of Armenia "On National Water Policy", adopted in 2006, follows the guidelines evolving from *Article 15* of the Water Code of the Republic of Armenia for: 1) Sustainable Water Resources Management; 2) Water resources use and protection priorities; 3) Accounting and

assessment of water resources; 4) Formation of Water Resources Demand; 5) Relations pertaining to water basin management.

AZERBAIJAN

The water sector development of the Azerbaijan is historically focused on the irrigation system and flood protection more than prevention and preparedness. Water resources management is regulated by the Water Code n 418-IG of 26 December 1997.

The Water Code establishes that appropriates normative secondary acts on flood management should be prepared by relevant executive authorities; however, none of the existing legal and regulatory acts consider flood risk assessment and integrated flood risk management planning. Water Code of Azerbaijan requires a significant upgrade and alignment to the EU standards, including a clear concept of the principle of basin management, integrated water resource management and the definition of flood risk.

Secondary Law under the Water Code needs to be developed in order to include EUFD provisions and principle in national regulation, starting with a clear inclusion of the basin management principle and the concept of flood risk assessment. Some activities in the direction of improving the legal and institutional framework are in progress, i.e.: a draft water strategy has been prepared but not approved yet; the Azerbaijan State Commission for cooperation with EU[10] has elaborated an action plan for the period 2015-2020 for the harmonization of legal framework of Azerbaijan to the *EU acquis*. The Action Plan should include a chapters dedicated to Water Resources Management (key figures are MENR and SAWR of MES) and inclusion of the provision of EU Floods Directive into national legislation.

BELARUS

Belarus has not yet officially transposed EUFD in its national legal framework and there is no harmonization among the existing Belarus Program Engineering Protection Measures from Flood for population and agriculture for 2005-2010 and other EU-directives including EUFD and Water Framework Directive (WFD).

EUFD has been mainly implemented through international projects and single basin-scale initiatives. The main actor in the implementation of these projects is the Central Research Institute for Complex Use of Water Resources (CRICUWR) under the Ministry of Natural Resources and Environmental Protection (MoNREP).

The Water Code of the Republic of Belarus has been developed in 2013 by the MoNREP entered into force on 21 May 2015. The Water Code uses approaches included in the WFD and particularly the use of a “river basin management principle” in the form of Basin Councils.

The hydro-meteorological data provision has been addressed by the Presidential Decree of January 23, 2007 № 75 On the implementation of the Law "On hydrometeorology” approving the regulations on the provision of hydro-meteorological data of the MoNREP of Hydro- Meteorological information not included in the State Hydro-meteorological Service, the regulations on the procedures of state control in the field of hydro-meteorological activities, the regulations on the procedure of managing the state register of producers of hydro-meteorological information and certificate their registration as hydro-meteorological information providers, the regulation on the establishment and designation of guarding

[10] *Permanent Commission Chaired by the Ministry of Economy and Industry*

zones around fixed points of observation of the state network of hydrometeorological observations, as well as the requirements for their protection and use.

GEORGIA

Georgia has a long tradition of shaping its laws and decrees taking as an example the EU legislation. As a result of that many pieces of legislation are already oriented towards the requirements of the EUFD.

However Georgia has not yet officially transposed EUFD in its national legal framework, but started a series of preparatory actions in order to approximate to the EUFD. Georgia signed the EU – Georgia Association Agreement and Association Agenda, which aim to promote the dialogue and approximation of EU legislation on items such as civil protection and floods management, this agreement has the EUFD amongst its priority. Within such framework the Ministry of Environment and Natural Resources Protection (MENRP) through its DRR office initiated a series of consultations with EU Member States experts to assess the gaps in the Georgian legislation in order to reach the approximation that resulted in the drafting of a Road Map for the approximation to the EUFD. Georgia is seeking for support in the Road Map implementation.

Georgia legislation is undergoing deep changes all possibly connected with the EUFD. Mentioning the most relevant ones: the Law on Civil Security entered in force in 2014 that foresees enhanced mandates for the newly constituted Emergency Management Agency (EMA) within the Ministry of Internal Affairs many of which related to flood risk assessment and flood risk management. In particular EMA is now in the process of defining sub-legislation that includes content of Disaster Emergency Management Plans (DEMP) including floods. Depending on the decision taken in drafting such sub-legislation DEMP can cover a substantial part of the contents included in a Flood Risk Management Plan (FRMP) that is the final goal of the EUFD.

The newly created State Security and Crisis Management Council (SSCMC) is in the process of drafting and getting approved both a National DRR Strategy and a DRR Action Plan that will include the approximation to the EUFD by the end of the 2015.

Georgia is also about to adopt a new Water Code developed by the Ministry of Environment and Natural Resources Protection (MENRP) that includes important links with the Water Framework Directive (WFD) as well as with EUFD.

All these pieces of legislation aim at an increasing flood protection level, this intention is also represented in the annually updated Mid-Term Expenditure Framework (MTEF) for 2013-2016 where disaster prevention is one of the priorities in the Environment Sector.

The Ministry of Economy and Sustainable Development is also in the process of drafting a National Sustainable Development Plan (NSDP) that has environmental issues and risk derived from natural hazards integrated in it.

However, despite the favorable legislative setup all these Laws, strategies and plans lack in inter-institutional coordination and this leads sometimes to an unclear or conflicting roles and mandates of the different institutional actors. This leads to difficulties in finding a mandated institution or body for the development of a coordinated Flood Management Plan (FMP) that has the natural catchment as a target area and domain.

MOLDOVA

Water and flood management legislation of Moldova has been extensively transformed in the last years and harmonized to several EU Directives. The Water Law nr. 272 of 23 December 2011, effective since October 26th 2013, partially, though substantially, transposed the following directives:

- Water Framework Directive (WFD) no.2000/60/EC of 23 December 2000 (WFD),
- Urban Waste Water Directive no.91/271/EEC of 21 May 1991,
- Nitrate Directive no.91/676/EEC of 12 December 1991,
- Bathing Water Directive no.2006/7/EC of 15 February 2006 and
- Floods Directive no.2007/60/EC of 23 October 2007.

Specifically, the art. 49 of Water Law 272 provides that flood risk management is regulated by a dedicated sub-law which has been elaborated and approved as Governmental Regulation on Flood Risk Management no.887 of 11 November 2013. The Regulation identifies the Ministry of Environment (MoE) as a responsible body for the implementation of the legal act. The Regulation is substantially in line with the requirements of EUFD for the preparation of Preliminary Flood Risk Assessment (PFRA), Flood Hazard Mapping (FHM) and Flood Risk Mapping (FRM) and Flood Risk Management Plans (FRMPs). It also sets a review and updating process of the plans and a monitoring mechanism for the implementation of the measures. The main discrepancy with EUFD is that the Regulation does not set a time limit for completing PFRA, FHM, FRM, FRMPs.

UKRAINE

In the wake of the association agreement between Ukraine and EU signed on 17 September 2014, EUFD was object to an action plan approved by the Decision of Cabinet of the Ministers 419 on 25 March 2015, as well as the Plan of Implementation of Directive 2007/60/EU was approved by the Resolution of the Cabinet of Ministers of Ukraine 132 on 25 February 2015.

This plan states that an analysis of compatibility of Ukrainian body of law with the EU acquis communal will last until the end of 2015. The working group specifically working on EUFD approximation under State Emergency Service (SES) leadership must coordinate its activity with an overarching group led by Ministry of Ecology and Natural Resources (MENR) on the Water Framework Directive (WFD).

The Association Agreement among the European Union and the European Atomic Energy Community and their member states, of the one part, and Ukraine, of the other part contains the road map for the EUFD implementation, namely:

- two years since the ratification to establish the units of management
- four years since the ratification to complete the preliminary flood risk assessment
- six years since the ratification to complete flood hazard and flood risk mapping
- eight years since the ratification to draft flood risk management plans.

Key implementers of EUFD will be SES (national coordinator), MENR – being the main authority in the system of central executive bodies in the formation and realization of state policy in the field of water management – and the State Agency for Water Resources (SAWR is the central executive power body, whose activity is coordinated by the Cabinet of Ministers of Ukraine through the Minister of Ecology and Water Resources and who carries out the state policy in the field of water management and hydro technical land reclamation, surface water resources management, use and recovery).

For Flood Hazard (FHM) and Flood Risk Mapping (FRM), the Ukrainian Hydro-Meteorological Institute (UHMI) will be the main implementer. The needed hydro-meteorological data will be provided by the Ukrainian Hydro- Meteorological Centre (UHMC). Water objects, their areas that the inundation maps and flood risk maps are developed for, as well as the order of their development will be determined by the SAWR.

Taking into account that the National Academy of Sciences - Institute of Mathematical Machines and System Problems has its own methodology for calculating and developing inundation maps (see clause

4.2.1 below), it is reasonable to involve it alongside with UHMC in developing such maps within the framework of the EU Floods Directive.
To be compliant with EUFD, efforts will be then taken to upgrade and optimize the national legislative framework (e.g., the Ukrainian Water Code) and the structure of Ministries and agencies related to the matter (e.g., the hydro-meteorological bodies).

4.1 Units of Management and Institutional Framework in Partner Countries

The organizational structures, rules and norms of Institutional Framework are vary from country to country. Institutional structures are essential to have mechanisms for dialogue and co-ordination. The Unit of Management is a key concept of both EUFD and EU WFD and both Directives require to define a unit of management and associated management authority/organization based on the river basin management principle. Trans-national river basins have inter-institutional river basin council/committee for the purposes of developing and implementing River Basin Management Plan and Flood Risk Management Plans at basin level.

Below a short description of organizational structures and UoMs of each partner country is presented.

ARMENIA

Institutional Framework

The competent authority for water management in Armenia is the Water Resources Management Agency (WRMA) by the Government of Armenia. The WRMA with its 6 Basin Management Organizations (BMOs) operates under the Ministry of Nature Protection (MNP) and is responsible for development and implementation of Water Basin Management Plans (WBMPs), along with the other main tasks related to water resources management in compliance with the National Water Policy and the National Water Programme, and the definitions and prescriptions of the Water Framework Directive.
The Ministry of Agriculture has been recognized (16 August 2007) as state governing authorized body for organization and implementation of measures for prevention and elimination of adverse impact on river waters foreseen by the Water Code. Specifically, the Ministry of Agriculture is responsible for:

- anti-flood measures implementation;
- inventory of rivers and drainage systems in the country;
- creation of the database reflecting the actual state;
- development of programs on anti-flood measures;
- compiling design documentation and organization of works, operation and maintenance of bank protection structures.

The Ministry of Agriculture collaborates with regional government, community municipalities, as well as with state governing bodies and other parties that have experience and role in sector of anti-flood measures. The Ministry of Territorial Administration and Emergency Situations (MTAES) annually presents proposals to the Ministry of Agriculture on implementation of necessary preventive measures that have been developed as a result of studies of flood prone hazardous segments of beds of rivers, drainage systems and flood control systems.
State Committee of Water Economy (SCWE) is a state body within the structure of the Ministry of Agriculture. SCWE develops and implements the policy of the Government of the Republic of Armenia in the area of water systems that are considered as state property and non-commercial water supply

systems management and utilization, including all the functions associated to the hydro technical structure.

Units of Management

According to the Water Code of the Republic of Armenia, the National Water Policy and the National Water Program, the WRMA has established Basin Management Objectives (BMOs) (one for each major Armenian basin); however, the BMOs are divisions within WRMA rather a coordination body among several institutions and stakeholders.

AZERBAIJAN

Institutional Framework

The Organization Charter defined by the President and Cabinet of Ministries is a key element of the Azerbaijan legislation. According to the Charter, the responsible body for proposing new National Water Policy for the approval to Government (Cabinet of Ministers) and the Parliament (Milli Majlis) are: the Ministry of Ecology and Natural Resource (MENR), which also acts as owner of the country water resources by approving water utilization permit, and the Ministry of Emergency Situation (MES). MENR is responsible also for environmental management and monitoring, including monitoring of atmosphere (precipitation and other variables) surface and ground water (quality and quantity), weather forecasting, climate change adaptation and registration of environmental data.

Water management is distributed among multiple actors, namely: State Water Resources Agency (SWRA) of the MES, Ministry of Energy and Land Reclamation and Water Management OJSC . Azersu operates water supply, while Water User Unions distributes water to farmers for irrigation purposes.

The SWRA is the executive body for the improvement of water resources management. SWRA continuously provides verification of the technical condition of water reservoirs and other hydro-technical facilities, monitoring of water bodies, surface water and groundwater and water systems in the country and it is responsible for safety and security of reservoirs of national importance.

SWRA of MES, MENR and OJSC are responsible for flood management.

The National Department for Hydro-meteorology of MENR is responsible for meteorological and hydrological forecast and monitoring. The monitoring and forecasting division have a good number of forecasters. The Division produces regular meteorological bulletins containing warnings.

Units of Management

The current Water Code both includes the river basin management principles and the administrative border management criteria; it does not clarify which criteria must be used and, as a result, the administrative border criteria is the one adopted in practice. Regional EU funded programme for Environmental Protection of International River Basins (EPRIB) is promoting the adoption of the River Basin Management principles and is supporting the preparation of River Basin Management Plan in pilot catchments, however there is a need to include the River Basin Management principles in the Azerbaijan legislation and to build an appropriate institutional framework based on water basin bodies.

BELARUS

Institutional Framework

Defined by Water Code Basin Councils ("river basin management principle") are inter-ministerial (inter-departmental) and inter-territorial advisory bodies and their decisions are recommendatory. The activity of Basin Councils and the procedure of their establishment are governed by the respective Regulation adopted by the Resolution of the Council of the Republic of Belarus of 02 March 2015 # 152 and the Resolution of the Ministry of Environment of 04 May 2015 # 19. As per the said regulations the activity of Basin Councils is carried out without establishment of "secretariats", on the basis of territorial (regional) bodies of the Ministry of Natural Resources and Environmental Protection (MoNREP).

Accordingly to WFD principles, the Water Code fosters the development of RBMPs for the main rivers flowing through Belarus, namely: Dnieper, Pripyat, Western Bug, Nieman and Western Dvina. The MoNREP organizes the development of draft of RBMPs with participation of concerned state bodies (organizations). In accordance with article 15 of the Water Code of the Republic of Belarus River Basin Management Plans (RBMPs) are approved by joint decision of regional executive committees on whose territory the river basin is located. The requirements for the development, preparation and design of drafts of RBMPs are established by the MoNREP.

Units of Management

At present, Belarus has no basin institutions, nevertheless the recently approved Water Code nurture the use of a "river basin management principle" through the constitution of Basin Councils on the base of the territorial bodies of the MoNREP, in compliance with WFD.

GEORGIA

Institutional Framework

The responsibilities on water management in Georgia are mainly divided among following authorities:

- Emergency Management Agency
- Ministry of Environment and Natural Resources Protection (MENRP) - National Environmental Agency
- Ministry of Economy and Sustainable Development
- Ministry of Agriculture
- Ministry of Internal Affairs
- The newly created State Security and Crisis Management Council (SSCMC) under the Prime Minister Office is another key player for the EUFD.

The National Environmental Agency of the MENRP is responsible on Hazard Mapping in case of flooding. Since NEA has the technical capacities to develop mapping product internally or in connection to ad hoc projects.

Units of Management

The new Water Code could help in the definition of Units of Management that could serve both the WFD and the EUFD implementation. There are no basin management districts identified and managed in Georgia so far and this should be one of the focuses of the new Water Code. Such Code is in line with

the National Environmental Action Programme of Georgia (2012 – 2016) developed by the same Ministry, which has a dedicated section on disasters including the ones related to floods.

MOLDOVA

Institutional Framework

The institutional framework of Moldova for flood risk management is complex and includes many institutions belonging to two main governmental bodies, namely Ministry of Emergency (MoE) and Ministry of Internal Affairs (MoIA). Apele Moldova, State Hydro-Meteorological Services, State Enterprise Water Basin Management Authority, State Environmental Inspectorate Department are subordinated structures of the MoE.
Moreover, the Institute of Ecology and Geography belongs to MoE and the National Academy of Sciences.
The Civil Protection and Emergency Situations (CPESS) of Moldova within MoIA is the leading organization for emergency management.
Apele Moldovei (MoE agency) implements the state policy in the field of water resources, flood protection and irrigation. Apele Moldovei established the State Enterprise Water Basin Management Authority[11] for the management of water resources, coordination of water permits, the population of the water cadastre, monitoring of water use and for contributing to the development of environmental information system of MoE (www.gismeliu-gov.md and http://www.dbga.md/siga.html).
The State Hydro-Meteorological Service[12] (SHS) (subordinated to the MoE) is responsible for hydrological and meteorological monitoring through the automatic and manned ground station and radar network. SHS service provides weather forecasts for the entire Moldova and hydrological forecasts for main river basins.
The State Environmental Inspectorate[13] of the Ministry of Environment is responsible for field control, monitoring, mapping and delineation of river basins, inventory of river basins, inventory of industrial facilities, monitoring of dams in coordination with Apele Moldovei.
The Institute of Ecology and Geography of the Academy of Sciences of Moldova and MoE is a scientific institution that provides technical and scientific support and training on: geo-ecological disasters, implementation of environmental and natural resources' GIS, meteorology, climatology and agro-meteorology.
CPESS is a service within the MoIA and its mandate and function focus on disaster preparedness, response and emergency management. The recently established headed by CPESS National Centre for Managing Emergency Situations acts as a coordination body of the political and technical levels for emergency management and disaster.

Units of Management

In Moldova, river basin districts and sub-basins have been determined and adopted with the Government Decision Nr. 775 of 10 April 2013.
Hydrographic district basin Committees have been also established for the Dniester River and Prut, Danube and Black Seas catchments. Local authorities, water companies and other stakeholders could compose Sub District Basin Councils. Moreover, 39 sub-basins have been designed: in this case the

[11] (State Enterprise "Basin Water Management Authority" Moldova at link http://www.dbga.md/#)
[12] (State Hydrometeoroogical Service of Moldova at link http://www.meteo.md/newen/administraciaen.htm)
[13] (State Ecological Inspectorate of Moldova at link www.inseco.gov.md)

authority in charge is the River Sub-Basin Council coordinated by local authorities. No clear mandate and procedures for the functioning of River Basin Committees and River sub-Basin Councils exist, hampering the implementation process especially for the River Basin Committee. However, it must be noted that some river sub-basin councils (i.e. River Bic Council[14]) have been activated, nominating members and establishing technical working groups.

Law determines Hydrographic Basin District Committees and sub-basin councils. However, their functioning is at very early stage especially for the two River Basin Committees (Dniester and Prut, Danube and Black Seas catchments). The Swiss Agency for Development and Cooperation and the Austrian Development Agency are supporting MoE in order to establish an institutional connection between River Basin Committees and River Sub-Basin Councils and to reform Apele Moldovei by establishing a dedicated department for the management of the two river basin districts.
Flood management in international river basins is regulated by ad-hoc agreements. The Republic of Moldova has signed two international agreements for water resources management in trans-national river basin:

- Agreement between Moldova and Romania on cooperation for the protection and sustainable use of waters of Prut and Danube;
- Agreement between the Republic of Moldova and the Cabinet of Ministers of Ukraine on cooperation in environmental protection and sustainable development of the Dniester River Basin, 2012.

UKRAINE

Water management in Ukraine has traditionally been administered by different entities.
The Ministry of Agrarian Policy and Food is, responsible for the design and execution of irrigation and drainage schemes and maintenance of the irrigated and drained areas. The Ministry of Energy and Coal Mining is responsible for water management for production of hydroelectric power. The Ministry of Infrastructure is responsible for the management of canals and rivers for transportation and navigation.
With regard to international relations, Ukraine has bilateral intergovernmental cooperation agreements on water use with neighboring countries (Poland, Hungary, Slovakia, Romania, Belarus, Moldova and Russia. The agreement on the Treaty between the Government of the Republic of Moldova and the Cabinet of Ministers of Ukraine on Border Waters Common Use and Protection.
An essential platform for developing trans-border cooperation with Moldova is the Bilateral Treaty on the Sustainable Management between the Government of the Republic of Moldova and the Cabinet of Ministers of Ukraine on cooperation in the field of protection and sustainable development of the Dniester river (it has not been ratified in Ukraine yet). This Treaty contains the provisions concerning the measures meant to prevent and mitigate the harmful effect of waters, including floods and sudden overflows.
Basin Administrations for Water Resources (BUWR) is State-financed non-profit organizations under SAWR. For the Dnieper River, BUWR supports the implementation of government policies on the management, use, regeneration and protection of water resources, the development of water economy, and the operation of water facilities and waterside structures within the Dnieper basin.

Units of Management

[14] (River Bic Basin Counsil at link http://www.riulbic.md/en/index.php)

Basin Administrations for Water Resources and Oblast Administrations for Water Resources have been created and functioning in the system of SAWR. Basin Councils as advisory bodies have been created in the main river basins. Councils work in close cooperation with SAWR and, if existing for a specific basin, Basin Administrations for Water Resources (BUWR), Ukrainian Hydro-Meteorological Center, regional and oblast hydro-meteorological organizations.

5. Preliminary Flood Risk Assessment (PFRA)

This section contains Preliminary Flood Risk Assessment definition in terms of EUFD. An overview of current status of Preliminary Flood Risk Assessment in EU Member States is done on the base of "Report on the progress in implementation of the Floods Directive"[15] (2015). The current status of Flood Risk Assessment in EaP countries based on last updated Country Profiles of 2015 is presented.

5.1 Scope and objective of PFRA

Preliminary Flood Risk Assessment (PFRA)[16] is related to areas where potential significant flood risks exist or are probable in the future. Such areas are identified as Areas of Potentially Significant Flood Risk (APSFR) in the preliminary flood risk assessment. If in a particular river basin, sub-basin or stretch of coastline no potential significant flood risk exists or is reasonably foreseeable in the future, no further action would have to be taken.

EU Member States (Article 13) 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 already undertaken a risk assessment, prepared flood hazard maps and flood risk maps, established flood risk management plans in accordance with the relevant provisions of the Floods Directive.

The assessment of PFRA should be based on already existing data and studies: the aim is to identify those areas where Potential Significant Flood Risk exists or might be considered likely to occur.

The articles 4 and 5 of EUFD define PFRA activities.

Article 4

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

2. 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:

[15] (EC Report on the progress in implementation of the Floods Directive (2015) at link http://ec.europa.eu/environment/water/water-framework/pdf/4th_report/CSWD%20Report%20on%20the%20FD%20.pdf)

[16] (A Communication on Flood risk management; Flood prevention, protection and mitigation at link http://ec.europa.eu/environment/water/flood_risk/com.htm)

(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.
3. 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 takes place between the competent authorities concerned.
4. Member States shall complete the preliminary flood risk assessment by 22 December 2011.

Article 5
1. On the basis of a preliminary flood risk assessment as referred to in Article 4, Member States shall, for each river basin district, or unit of management referred to in 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.

2. The identification under paragraph 1 of areas 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.

5.2 Overview of Preliminary Flood Risk Assessment in EU Member States

The "European Overview Assessment of Member States' reports on Preliminary Flood Risk Assessment and Identification of Areas of Potentially Significant Flood Risk"[17] (2015) provides an overview of current status of PFRA in EU Member States.

According to the report "MSs were required to report electronically to WISE by 22 March 2012 their PFRAs. By November 2013, all Member States, with the exception of Portugal, had provided some, if not all, of the requested information on their PFRAs and on the Articles they would be applying. Portugal informed the Commission bilaterally as to which Article they would be applying.

There are large differences in the way MSs have applied either Article 4 or the transitional arrangements under Article 13.1. Some have applied one of the Articles to their whole territories for all relevant flood types whereas others have applied a different Article to specific flood types within their territories. The most complex situation is in Germany where a combination of Article 4, Article 13.1(a) and Article 13.1(b) has been applied between Units of Management, and even within the same Unit of Management. In the United Kingdom, Article 4 is applied in all Units of Management but in the Unit of Management in England and Wales it is applied to specific flood types (pluvial, groundwater and minor watercourses) and Article 13.1(b) is applied to other types (raised reservoirs, sea water and main rivers).

Article 4 requires the assessment of certain aspects when undertaking a PFRA based on available or readily derivable information. The majority of these aspects were considered in the majority of the 21 MSs reporting on a PFRA. The aspects most commonly not considered include the effectiveness of man-

[17] (EU Report on PFRA (2015) at link http://ec.europa.eu/environment/water/flood_risk/pdf/pfra_reports/EU%20PFRA%20Overview%20Report.pdf)

made flood defences (eight MSs); conveyance routes of historical floods (six MSs); geomorphological characteristics (six MSs); and areas of economic activity (five MSs).

Some MSs have considered all types of relevant floods to be included in the scope of the Directive whereas others have not but without explanation of why. Where reasons have been given, some types of floods have been excluded because of their unpredictability or insufficient data availability. Other MSs have excluded certain types of floods for this implementation cycle but have indicated that they will include them in future Floods Directive cycles.

Criteria to define significant historical floods and reasons for not including some types of floods that occurred in the past are very diverse and broad. The definition of significance included:

- impacted area;
- amount of monetary compensation;
- return period, flood extent and duration of the event;
- use of specific weighing systems for consequences to assess significance;
- non-comparability of hydrological circumstances (too long ago);
- significant changes of land use since the event make the consequences no longer relevant;
- the absence of historical evidence for their occurrence and/or significance.

Some MSs have not provided information on the criteria used to define significant historical floods

The methods used to identify and quantify potential future adverse consequences and impacts are also very diverse between MSs. Modelling (hydrological and hydraulic) has been used but the detail has often not been reported. Where GIS analysis has been used, the approach and methodology differs between MSs. The use of flood return periods or probabilities is different between MSs varying from 5, 10, 20, 50, 100, 200, to 1,000 years. Often a combination of the methods has been applied by the MSs.

Sixteen of the 23 MSs with reported information considered climate change in their assessments of flood risk. Seven did not, and there was no information for the remaining five MSs. In most of the 11 MSs which have considered long term developments other than climate change, the methods used to assess them are unclear.

48,023 APSFRs were reported from 23 MSs with Croatia reporting the most (2,976) and Hungary the fewest (2). Malta applied Article 4 but did not identify any Area of Potential Significant Flood Risk. Most (91%) APSFRs are associated with fluvial flooding and only 0.3% with groundwater flooding. There is large variability on the reporting of types of consequence associated with Area of Potential Significant Flood Risk between MSs with Poland reporting adverse consequences as "not applicable" and Denmark only reporting economic consequences."

Conclusion

"The reported information on some aspects of administrative arrangements for the FD is in some case incomplete and/or unclear. It is recommended that further clarification is sought from the respective MSs on these aspects. The methods associated with defining significant floods (historic and potential future) and significant adverse consequences were often superficially reported to WISE and often there were no more detailed methodological reports available. A more detailed understanding of the methods used by MSs would be required to make a more quantitative comparison of implementation of the Directive across the EU. The relevant methodological documents should be requested from MSs particularly when the assessment of Flood Hazard Maps and Flood Risk Maps is undertaken during the next phase of checking the implementation of the Floods Directive."

5.2.1 Good Practices on PFRA in selected EU Member States

This section provides two examples of excellence of Germany and Ireland on Preliminary Flood Risk Assessment (PFRA) according to EU Floods Directive (2007/60/EC) requirements. Each country profile is divided into four paragraphs: General description, Methodology, Outcomes, and References. The first paragraph General description provides main information on legislation and stakeholders. The second paragraph Methodology describes techniques used for PFRA. The third paragraph Outcomes contains some real examples as maps, screenshots, etc. The last paragraph References provides a list of web links and official documentation related to PFRA development.

PFRA Germany

General Description

The EUFD was transposed into German national law by means of the Federal Water Act (WHG) of 31 July 2009 (Federal Law Gazette BGBl I p. 2585). The Act entered into force on 1 March 2010.
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 2007/60/EC" developed by LAWA (German Working Group of the Federal States on Water Issues – Bund/Länder Arbeitsgemeinschaft Wasser).

Methodology

According to the 2007/60/EC, criteria for human health, for the environment, for cultural heritage and for economic activities are mentioned and detailed. Other criteria are mentioned comprising the number of affected inhabitants, number of affected buildings, expected monetary damage (in Euro), inundation depth and flow velocity, significant infrastructure, already realised precaution measures against floods, existing precaution measures and damage prevented by those measures.
The LAWA "Recommendations for the Establishment of Flood Risk Management Plans" of 2010 aim is to ensure that the content and design of the maps are standardised as far as possible, thus ensuring that the set of maps produced has nationwide coherence. The deadline for PFRA action in Germany in order to identify the areas/water bodies for which potential significant flood risks exist was end of 2011.
When making the preliminary assessment of flood risk, factors such as experiences from historical events, foreseen impacts of climate change and foreseen social consequences from a flooding should be taken into consideration.
The preliminary assessment of flood risk based on Art. 2 (2) of the EU Floods Directive provides the information on areas with present or future potential significant risks of flooding. The assessments consider all potential sources of flooding such as from rivers, lakes, coastal waters, groundwater and surface water flooding from heavy rainfall. Artificial structures holding water, such as dams, reservoirs and canals, also represent a potential significant source of flooding, particularly if there were to be a catastrophic failure of the structure.
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.

Outcomes

On Geoportal are provided thematic maps on flood protection substantial for PFRA: past extreme flood events, river basins, dams, detention basins.

Several International projects are provide PFRA of International River Basin Districts. The methodology can vary among different projects.

- IKSE MKOL International Commission for the Protection of the Elbe River;
- ICPDR Preliminary Flood Risk Assessment in the Danube River Basin;
- FLOOD-WISE - Elbe and catchment area of the Elbe in Brandenburg, river Rur / Roer;
- SAWA - The preliminary flood risk assessment has not been addressed by SAWA, as the pilot areas were selected precisely on the basis of their well known risk.

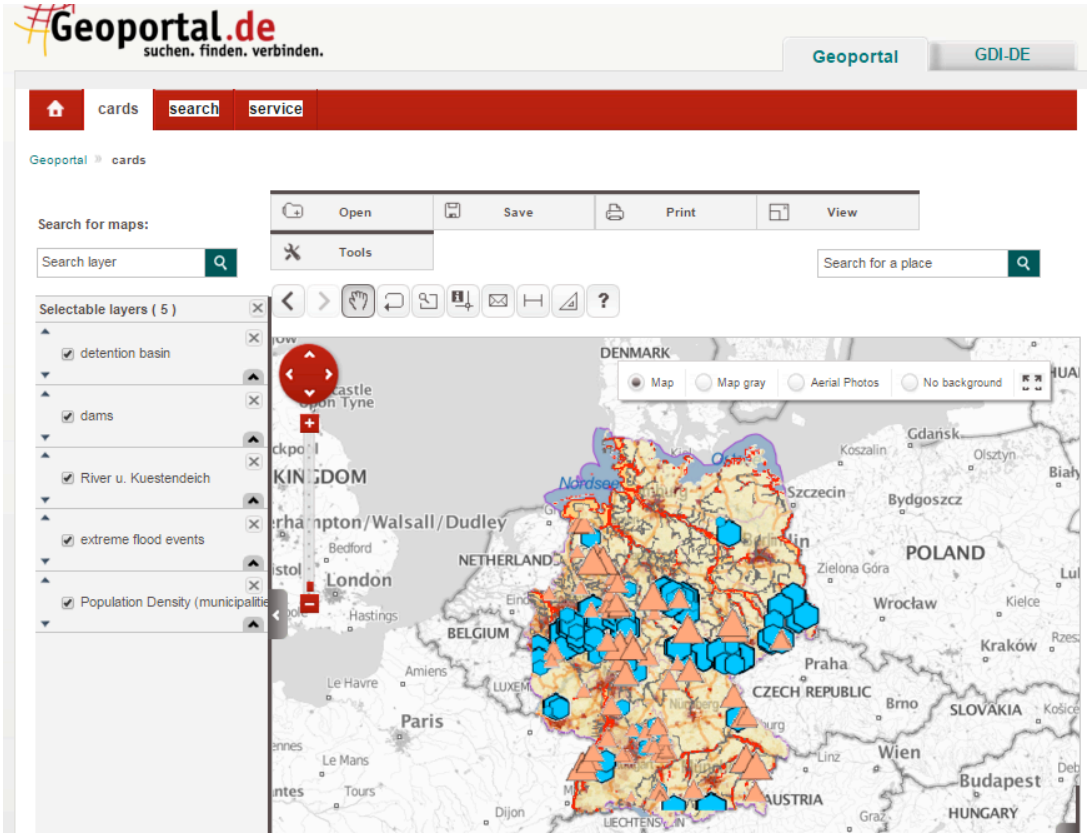


Figure 3. Geoportal Germany

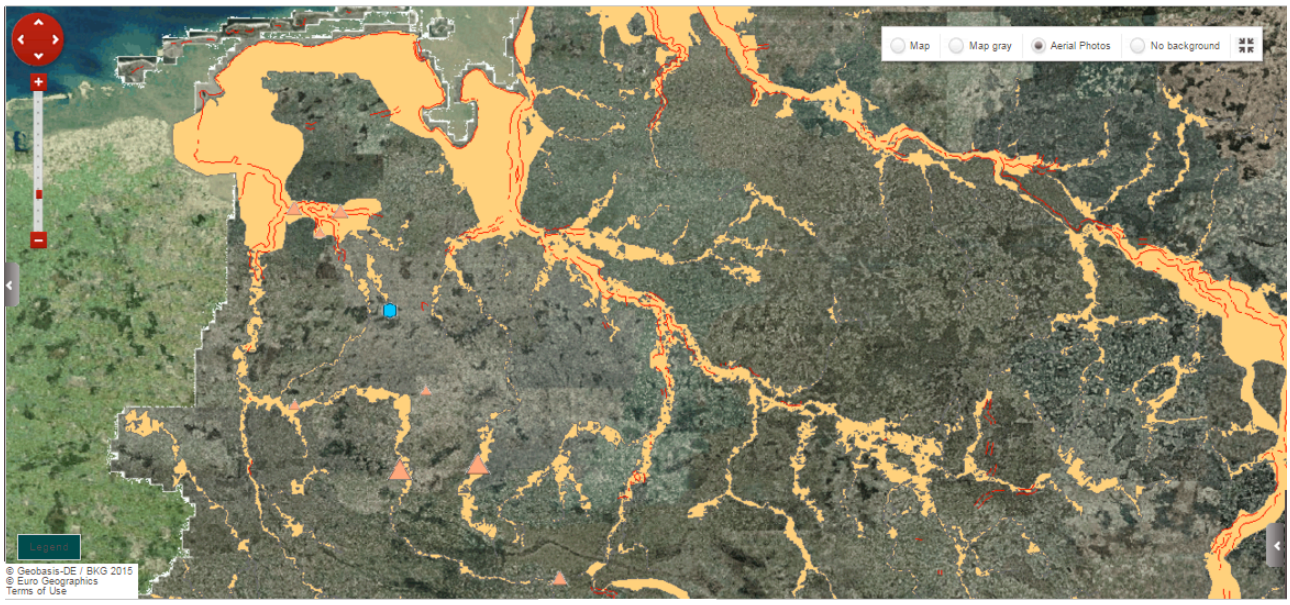


Figure 4. Past flood events on Geoportal, Germany

References

Flood Protection thematic map on Geoportal	http://www.geoportal.de/DE/Geoportal/Karten/karten.html?lang=de&lang=en&wmcid=64
Geoportal Germany	www.geoportal.de/
FLOOD-WISE Sub-Report, Phase 1: Inventory Flood Risk Assessment of the Elbe River Basin	http://floodwise.nl/wp-content/uploads/03-FRA-Subreport_phase1_Elbe_final.pdf
LAWA publications	http://www.lawa.de/Publications.html
SAWA Report - Adaptive Flood Risk Management Planning - Experience from the SAWA Pilot Regions	http://www.sawa-project.eu/uploads/documents/SAWA_WP1_Final_Report_Small_File1.pdf
ICPDR Preliminary Flood Risk Assessment in the Danube River Basin	file:///C:/Users/bedrina_t/Downloads/PFRA%20REPORT%20DRBD%20v%20March%202012.pdf
IKSE-MKOL Geoportal	http://geoportal.bafg.de/mapapps/resources/apps/IKSE_DE/index.html?lang=de

PFRA Ireland

General description

The Preliminary Flood Risk Assessment was made by Catchment Flood Risk Assessment and Management (CFRAM) national programme begun in 2011 with Preliminary Flood Risk Assessment. The CFRAM studies were carried out during 2011 and early 2012, and prepared detailed flood maps for the Areas for Further Assessment (AFAs) in 2013, according to EU Floods Directive. The studies includes also

development of Flood Hazard Mapping (2014) and Flood Risk Management Plans (2015) and provide a long-term strategy and prioritised measures to reduce and manage the flood risk.

Methodology

Three key approaches have been used in undertaking the PFRA to identify the AFAs:

- Historic Flood Risk Assessment: information on floods that have happened in the past.
    - Natural Sources of Flood Risk
    - Floods from infrastructure failure
- Predictive Analysis is an assessment of areas that could be prone to flooding, as determined by predictive techniques such as modelling, analysis or other calculations, and of the potential damage that could be caused by such flooding. The flood risk is a function, or combination, of the hazard and consequences. The Given the lack of available information on past flood extents, and the broader need for flood maps with a national coverage Office of Public Works (OPW) has determined predictive assessment suitable for Ireland.
- Consultation: use of local and expert knowledge of the Local Authorities and other Government departments and agencies to identify areas prone to flooding and the potential consequences that could arise. Other EU Member States have used similar approaches to undertaking the PFRA as that undertaken in Ireland.

The PFRA is not a detailed assessment of flood risk. It is rather a broad-scale assessment of communities, facilities and sites where the risk due to flooding might potentially be significant. The AFAs are subjected to more detailed assessments and analysis by CFRAM and parallel studies.

The PFRA considers flood risk arising from any major source of flooding, including:

Natural Sources:

- Rivers (fluvial, including increased flow from snowmelt)
- Sea (coastal and tidal)
- Groundwater
- Rainfall (pluvial)
- Tsunami (due to earthquakes, seabed landslips)

Infrastructural Sources:

- Urban Storm-water Drainage Systems (due under capacity)
- Reservoirs (due to breach of walls / embankments)
- Water Supply Systems (due to burst water mains)
- ESB Infrastructure (hydropower dams and embankments)
- Waterways Ireland Infrastructure (embanked canals).

To determine fluvial flood levels and then flood extents at each major node every 500m and intermediate node at 100 m spacing, a floodplain cross-section was derived from the OPW's national DTM. The flood level for out-of-bank flood flow was calculated using hydraulic calculation and based on the cross-section, slope and resistance to flow. Flood level was extrapolated across the crosssection to identify the outer extents of the flood on that crosssection. The outer extents of the flood were then linearly joined up to create a map of the projected flood extents.

Outcomes

The OPW database contains information on over 5,000 past flood events throughout the country.

On the National CFRAM Programme website are provided PFRA maps that indicate:

- Indicative areas potentially prone to flooding from natural sources of floodwater based on the preliminary analysis, and,

– Probable and possible Areas for Further Assessment (AFAs).

The PFRA maps were designed for all nodes with a catchment area greater than 1 km^2, for three flood event probabilities (the 10%, 1% and 0.1% AEP events). The OPW map viewer provides PFRA maps for national river network at scale 1:50,000 (Figure 6). The PFRA maps have indicative purposes and not used for local decision-making procedures without verification and seeking the advice of a suitable professional.

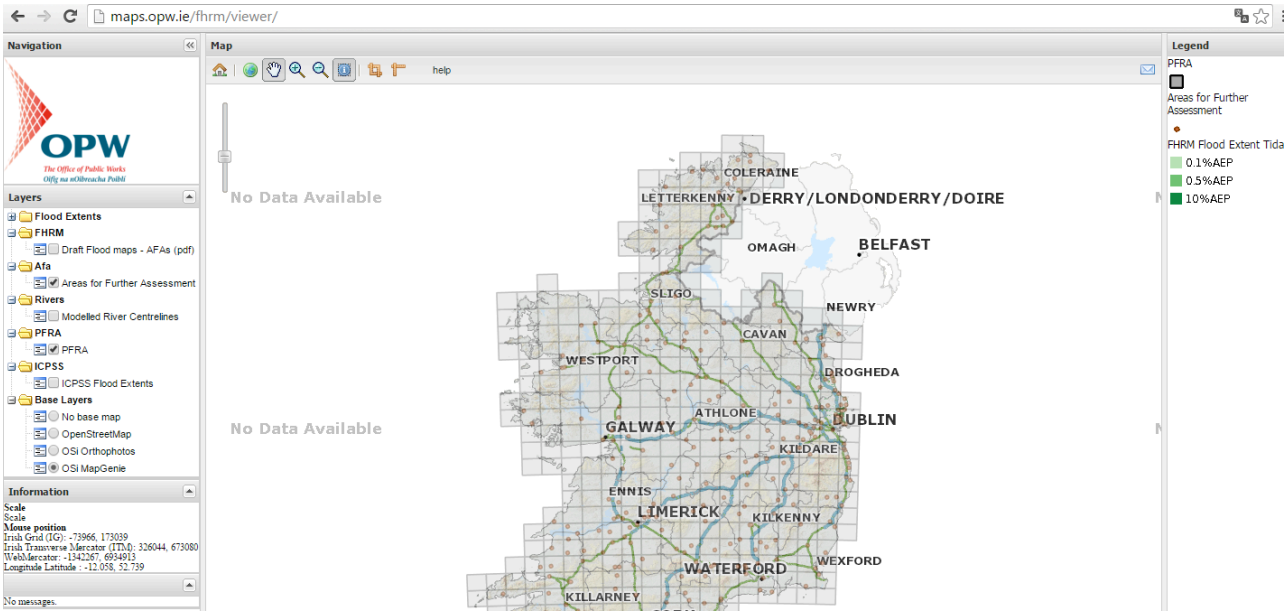


Figure 5. OPW map viewer

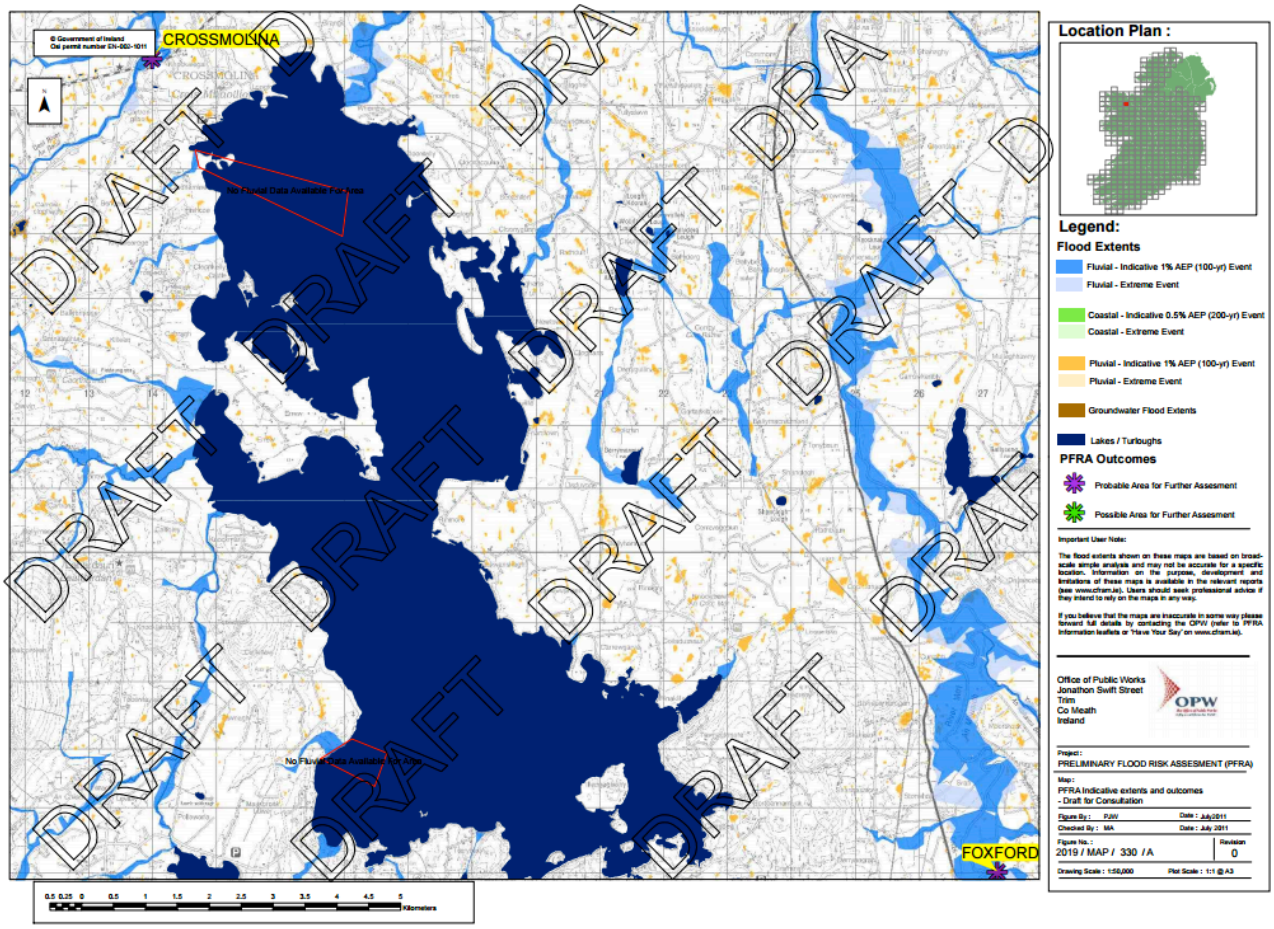


Figure 6. Preliminary Flood Risk Assessment maps, Ireland

References

Descriptions of the reported past floods are provided via the national flood hazard mapping website	www.floodmaps.ie
National CFRAM Programme website	www.cfram.ie
OPW maps viewer	http://maps.opw.ie/fhrm/viewer/
The national PFRA Report, March 2012	http://www.cfram.ie/wordpress/wp-content/uploads/2013/06/PFRA-Main-Report.pdf

5.3 PFRA Current Status of Preliminary Flood Risk Assessment in Partner Countries

In Table 2 is presented current status of PFRA in EaP countries detected during NAG meetings 2015. In general in all partner countries PFRA is developed only for main rivers financed by international projects. Only Georgia has PFRA of entire territory developed in 2011.

EaP countries	PFRA current status
Azerbaijan	is not developed; on-going activities in place
Armenia	initial tentative during PPRD East1 has been undertaken
Belarus	for the 5 biggest basins has been carried; refined data for some

	projects
Georgia	are available at national level from 2011. Need to be updated
Moldova	covers only the main rivers network and there is no clear criterion for the selection of the risk-prone areas
Ukraine	is mostly taken covered by means of pilot projects

Table 2. Current status of PFRA in EaP countries

In Table 3 are listed recommendations provided during NAG meetings to EaP countries. Some recommendations are the same for partner countries, some of them are developed considering national features of institutional structure and current status of PFRA.

EaP countries	training/capacity building programme for the institutional stakeholders	develop a common set of methodologies and techniques according to EUFD Articles 4 – 6	Additional
Azerbaijan	**V**	**V**	Start from a pilot basin. The methodology developed during PPRD East 1 should be used as a starting point
Armenia	**V**	-	-
Belarus	**V**	**-**	It is recommended to extend the detail analysis to the rest of the country
Georgia	**-**	**V**	Updating and enhancing the current PFRA starting from the Kura river basin as a Pilot
Moldova	**V**	**V**	Start from what has been already developed by MoE
Ukraine	**-**	**V**	Survey and maps drafting

Table 3. Summary of recommendations for PFRA development in EaP countries

ARMENIA

During PPRD East Phase 1, Institute of Geological Sciences - Armenian National Academy of Sciences (NAS IGS) was in charge for computing flood hazard and flood risk maps. A sort of preliminary risk assessment has been undertaken by analysing the MTAES database on floods. By doing that, much information about the event has been digitalized; nevertheless this analysis did not lead to definition and mapping of areas of potentially significant flood risk (APSFR).

AZERBAIJAN

Preliminary Flood Risk Assessment is not developed in Azerbaijan, however there are on-going activities that are related with the requirement of EUFD on Preliminary Flood Risk Assessment: collection of historical data on floods (MES), identification of flood prone areas , identification of element at risk (MES), flood Risk maps of PPRD East 1. Those actions surely represent a starting point for the full implementation of the EUFD.

BELARUS

PFRA in line with EUFD has been carried for the 5 biggest basins on the basis of historical floods database and APSFRs are available at district and basin scale. More refined data have been computed during pilot projects only for Western Bug, Iput river (Upper Dnieper basin) and part of the Pripyat.

GEORGIA

PFRA are available on the entire Georgian territory although they need to be updated as they are based on a study mainly developed in 2011. However they represent a valid start for the compliance with the EUFD requirements. The various international initiatives include development of PFRA component as one of the building block.

MOLDOVA

PFRA has been conducted by Beta Studio and HR Wallingford for the entire Moldavian territory under the Programme "Management and Technical Assistance Support to Moldova Flood Protection". MoE, with the financial support of the European Investment Bank, is implementing this Programme. As part of the Programme, the technical assistance has been tendered with the aim of preparing Preliminary Flood Risk Assessment for Moldova.
However, PFRA covers only the main rivers network and there is no clear criterion for the selection of the risk-prone areas.

UKRAINE

PFRA is mostly taken covered by means of pilot projects. Those actions surely represent a starting point for the full implementation of the EUFD but, nevertheless, inevitably provide a fragmented coverage with potential substantial methodological differences. In addition leaving such an important topic under the sole impulse of international support instruments, which are highly fluctuant, doesn't provide the programmatic stability required to develop a sound roadmap for a complex topic such as the EUFD.

5.4 Guidance and Methodologies for Preliminary Flood Risk Assessment

Implementing the EUFD is made possible through the establishment of more or less detailed data archives connected to all the information sources that are relevant to the fulfillment of more or less detailed studies for the approximation of each step provided for by Directive.

Data Management

For this reason all aspects in finding the information, analyze it, process it to produce the maps and publish the results in the manner prescribed by EUFD, should be the subject of a critical planning and targeted to create an effective subset whose elaboration will identify the flood risk areas and whatever connected at least with approximate methods, or if possible with more detailed studies.

In presenting the general framework of studies to be described in the following chapters, it is useful to consider that there are some common points in the various articles of the EUFD. In general it is needed to perform studies that arise with the collection of flood events in the past to get to predictive mapping, and calculations start from considerations even very simplified to arrive to detailed descriptions with the

evolution of the studies. It starts from the identification of Areas of Potential Significant Flood Risk, that are the spatial objects on which all subsequent studies are implanted. These elements in the truth can be represented with different geometry types: critical points, in the case of methods of identification based only on the simple localization of coordinates of previous events; areas with a dominant linear distribution, where the studies are linked to critical sections of waterways; areas with variable distribution, in the case the analyses are based on administrative units or compared to areas of variable amplitude around the sites of past events.

However, on these critical and strategic areas, it is necessary to provide the construction of multiple hazard and risk scenarios, each characterized by specific consequences that cannot be separated by a screening of the possible receptors of risk. The criteria for differentiation of risk receptors must be brought back to the classes Human health, Environment, Cultural heritage, Economic activity, or in a more concise way, Social, Environmental, Cultural, Economical The methods for assigning a weight to these receptors and assigning a value to their physical and possibly systemic vulnerabilities are characteristic of each area and a well-structured approach to the study cannot ignore the need of many passages of modeling and back-analysis aimed to identify the most appropriate values for the system you are analyzing. The absence of these critical filters may occur in extreme cases in which, starting from historical events of the past, the whole territory remains affected under investigation for the construction of future risk scenarios and all the affected areas have the same value for planning purposes, or on the contrary, only a very small portion of the country is taken into account.

So, in drafting a general scheme for the collection of data necessary to the implementation of EUFD, it has to be considered that, beyond the historic information on past flood events, whatever useful to the description of the territory and of the Social, Economic, Environmental, Cultural receptors could be used. At least a core dataset of minimum geospatial elements is needed:

- a description of the river network
- a description of the land use
- the distribution of population

This is an oversimplification, and certainly it is advisable, if possible, to have other additional information on population, objects of significance, areas and activities that could suffer harm in the event of a floods.

In this case it is possible to define the so-called Individual Receptors[18] (e.g. Hospitals, Power Stations, Airports, Schools), Areal Receptors (e.g. Cities, Villages, Environmental Sites), Social Infrastructure (e.g. Emergency Response Centres, Evacuation Centres), Critical Utilities (e.g. Water Supply & Treatment, Electricity, Communications) or even specific classes of population (e.g Vulnerable People - Elderly, Very Young)

Considering the needs for a proper application of models, of extreme importance are also: Digital Elevation Models (DEM), topographic maps, hydrological data, hydraulic structures and maps of flood extent of the past.

A specific attention should be paid to the scale of data and their compliancy with the scale of the studies; moreover, it must be checked for topological correctness and compliancy with international standards. About this point, the EUFD recommends the assessment of potential risk based on available

[18] (The EU 'Floods' Directive, Mark Adamson (2011) at link https://www.msb.se/Upload/Utbildning_och_ovning/Ovning/Barents_rescue/2011/Documentation/The%20EU%20floods%20directive.pdf)

or readily derivable information. Moreover, in the case of international river basin districts, or units of management which are shared with other Member States, Member States have to ensure that exchange of relevant information takes place between the competent authorities concerned.
This means that data have to be produced and shared using standard procedures and classifications.

The *Guidance*[19] *for Reporting under the "Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks" (Floods Directive)* aims at providing background information on reporting requirements according to the EUFD, supporting EU Member States in the structured preparation of information and data to be reported to the European Commission and giving explanations on how the European Commission intends to use the data for compliance assessment and drafting reports regarding the overall implementation of the Floods Directive in EU 27 Member States.

Reporting of floods related data and information through the Water Information System for Europe should ensure consistency and adequate information flows with other EU water legislation, notably the Water Framework Directive 2000/60/EC, the Drinking Water Directive 98/83/EC and the Bathing Water Directive 2006/7/EC and should achieve compliance with the obligations under the INSPIRE Directive. Please refer users of this report to the specific reading of the document mentioned above for an in-depth analysis of the use of data and information to check compliance and to ensure a consistent implementation of the EUFD throughout the EU as well as the use of data through other potential users.

Basic Data collection PFRA Phase 1

For the first phase of the PFRA the following basic data should be used:

1. CORINE land cover maps
2. Population density maps - quantitative information about population
3. River network
4. Historically flooded areas / floodable areas maps
5. Other geospatial data about exposure

A first survey should be done in order to define: availability of data, data owners, spatial coverage (local, regional or national) and its resolution, format (e.g. GIS maps, simple PDF, paper maps). As an example, the maps production of historically flooded areas could take advantage from archived local/crowdsoucing information on past events.

In order to proceed with PFRA evaluation it is recommended to adopt at least a reference grid as shown in Table 1.

DATA	availability	owner/distributor	extent/resolution	format
CORINE Land Cover				
Population density maps or similar				
River network				

[19] (Guidance for Reporting under the Floods Directive 2007/60/EC (2013-071) at link https://circabc.europa.eu/sd/a/acbcd98a-9540-480e-a876-420b7de64eba/Floods%20Reporting%20guidance%20-%20final_with%20revised%20paragraph%204.2.3.pdf)

Historically flooded areas/ floodable areas maps				
Other geospatial data about exposure				

Table 4. Reference table for PFRA survey on availability and accessibility of basic data

At the end of the survey, a proper plan strongly linked with the capacity building activities should be defined, and all data should be made available in a common digital GIS format.
The information collected during the survey could also consider and report about the kind of flooding process related to each flood event. The details of the different type of floods that are relevant in each area is mandatory in the second step of the EUFD (Flood Hazard and Risk Mapping) reported in the next chapter.

Preliminary flood hazard and risk maps – PFRA Phase 2

Once the Phase 1 has been completed, the operational process should move from the preliminary evaluation of the flood hazard to a preliminary flood risk evaluation. This should be done by combining the basic data obtained in Phase 1 to produce:

- Preliminary flood hazards (from: Historical floods / floodable areas + spatial buffer);
- Preliminary flood risk (from: Preliminary flood hazards + Population density maps + Other geospatial data about exposure);

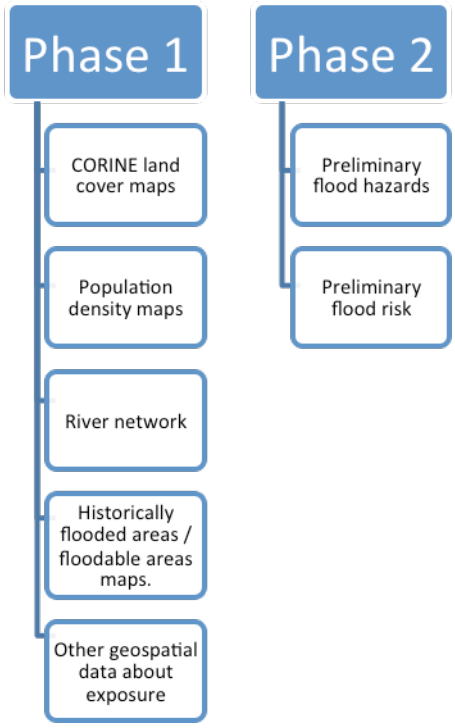


Figure 7. Preliminary Flood Risk Assessment

Preliminary Flood Hazard operational example

For the preliminary flood hazard evaluation, the following types of floods can be considered: Fluvial floods, Flash floods, Flooding due to overtopping and structural failures, Sea floods/ storm surges (if applicable), Failures of high dams.

At this stage a simplified methodology should be used in order to define the method (or the combination of methods) for flood prone areas identification with the aim to enable the classification and prioritization of areas considering the adverse consequences of flooding.

These methods include:

A. Geological approach, based on geological maps. In this hydro-geomorphological mapping method river beds are studied using topographic information (orthophotos, Digital Elevation Model-DEM) and geological information.
B. GIS approaches, we report in the following two examples:
   - "Water level rise" method that is based on the principle of rising the water level in the river bed. The accuracy of the results of this method depends on the quality of existing digital elevation maps
   - Another example is represented by the EXZECO (un code d'EXctraction des Zones d'ECOulement) Method[20] (developed in France) that is based on increasing the level of river basin water. The method runs with the existing digital elevation map. The accuracy of the map has a significant effect on the quality of the results. The outputs of EXZECO method was applied for Turkey only to make comparison with other methods and did not recommend to use this method in areas which have less steep slopes.
C. Simplified modeling methods.

Preliminary Flood Risk operational example

The maps of the preliminary risk receptors should be rank ordered and combined in order to obtain the Preliminary risk levels maps. The following elements could be considered flood risk receptors. These receptors are a first suggestion and represent a baseline version of the receptors in the PFRA phase:

- Settlements
- Industries
- Road, railways, transport lines
- Significant infrastructures
- Agriculture
- Forests, land fields and in general not-populated areas.

A final map defining the areas of Preliminary Flood Risk will then be prepared.

The operational process assigns risk indicators to flood-prone areas by overlapping them with the land use maps that report, in a simplified way, the risk receptors considered. As an example, one useful dataset to evaluate the elements exposed to floods is the land use reported in the CORINE Land Cover (CLC) maps and representing economic and human losses.

The flood-prone areas identified in the preliminary flood hazard assessment should be combined with a significant selection of risk receptors under potential future flood areas such as data survey readily available in a GIS format for each unit of management.

In Table 4 is given data survey of geospatial layers for the implementation of preliminary flood risk assessment studies or flood hazard and risk maps. It contains detailed list of assets and objects of

[20] http://www.jspacesystems.or.jp/ersdac/GDEM/E/4.html (data GeoTIFF format with geographic lat/long coordinates and a 1 arcsecond -approximately 30 m grid);

economic, strategic, environment and cultural significance, which should be included in mapping as the most vulnerable targets. Each layer should contain information on

- how it was made, by who, what contains: attributes assigned, indices, scale;
- data provider and/or possible data sources;
- format of layer: XML, shapefile etc.

	Layer	Description and scale	Data provider	Format of layer
1	Administrative boundaries			
2	Water districts			
3	River networks			
4	Groundwater sources			
5	Topography (Elevation, contour lines, ...)			
6	Land use/Land cover			
7	Buildings (Skyscrapers)			
8	Public buildings			
9	Population distribution			
10	Shelters and Refuges			
11	Museums			
12	Theaters, Cinemas			
13	Zoo, Aquariums, Terrariums			
14	Trade centers, Entertainment centers			
15	Places of Worship			
16	Sports facilities (stadiums, swimming pools , aqua parks, …)			
17	Hospitals and health care structures			
18	Urban parks			
19	Parking facilities (underground parking, multi-storey parking)			
20	Schools			
21	Kindergartens and homes for elderly people			
22	Educational institutes (Universities, Colleges, Academies…)			
23	Emergency Management operational centers			
24	Government buildings (Prefecture, Embassies…)			
25	Decision Making Authorities (in case of an emergency)			
26	Police and Fire Brigade Stations			
27	Stations (bus, railway, tram...)			
28	Railroads			
29	Roads			
30	Strategic linear infrastructures (bridges, tunnels,...)			
31	Strategic infrastructures (Airports/ Harbors/...)			
32	Pipelines/lifelines (electrical, gas, communication. water, sewage - lines and stations)			
33	Industrial sites, waste and wastewater management facilities			
34	Commercial sites			
35	Resort facilities			
36	Bathing waters			
37	Fabrics			

38	Industrial facilities			
39	Farms, grazing areas			
40	Plantations, agricultural fields			
41	Protected areas and parks			
42	UNESCO cultural heritage			
43	Gauging stations, Meteorological, Hydrological stations			
44	Hydraulic structures (dams, dykes, ..)			
45	Historical floods and past flood maps			
46	Flood Hazard maps			
47	Flood Risk maps			

Table 5. Data survey of geospatial layers

In this way it is possible to evaluate the Preliminary Flood Risk Areas in terms of simple administrative units (e.g. municipalities). As an example, for each administrative unit, should be identified the number (and possibly the position) of the areas at risk of flood. The indicators on each administrative unit, given for the purposes of decision makers, allow objective comparison and help to define APSFR by sub-river basin, river segments, by administrative boundaries.

Areas of Potential Significant Flood Risk

Once the PFRA are identified, the Areas of Potential Significant Flood Risk can be defined by using threshold values on the indicators related to the assessment of preliminary flood risk. The threshold values used for selecting APSFR are determined by indicators such as:

Indicator	Threshold Value
Urban residential areas at risk of flood	> 2 km2
Economic activity areas at flood risk	> 1 km2

PPRD East1 recommendations in PFRA establishment

The PPRD East1 Risk/Hazard Assessment Policy[21] EUFD provides some important details on PFRA process. It is is basically compliant with EUFD guidance. According to this guidelines , the risk assessment process should be undertaken through the development of a number of different methods.

Risk is defined as:

Risk = Hazard x Vulnerability x Exposure

The Risk Matrix approach was proposed by PPRD East1 Assessment Policy at national level to assist risk identification. The Risk Matrix approach can define a recordable disaster while also developing an understanding of where additional analysis is required. The identification of risks is proposed to

[21] (PPRD East1 Risk/Hazard Assessment Policy for the ENPI Eastern Region (2012) at link http://euroeastcp.eu/assets/files/Publications/Risk%20Hazard%20Assessment%20Policy_en.pdf)

undertake in a step-wise approach consisting of four components, according to "EC Risk Assessment and Mapping Guidelines for Disaster Management" [22] (2010):

a) scenario building;
b) extent of quantitative analysis (the extent of hazard that determines a risk);
c) number of risk and risk scenarios considered (amount deemed as requiring attention);
d) and temporal horizons (likely return period in the short term).

Three key elements were defined for identifying a hazard: - location (coordinates/ area); - probability of occurrence; and - intensity.

Consistent recording of hazards throughout the identification phase was recognized as essential to ensure separate hazard. Probability of occurrence can be considered as a percentage of a probable return period over a set length of time. Intensity otherwise known as impacts can be characterized in a number of different of ways, these include but are not restricted to:

- Cost – relating to the acceptable financial impact from a disaster in USD;
- Casualties – related to the total number of very significant injuries or human deaths as a result of a disaster may include: Effected people – relates to number of people reported as being injured and ill requiring hospital assistance; Displaced people – relates to the number of people displaced from their homes as a result of a disaster;
- Environmental impact.

Risk Identification

By PPRD EAST 1 Risk/Hazard Assessment Policy is proposed the use of the risk matrix during the risk identification stage for further developing of understanding of the risks and the impact they present at a regional and national level. The use of the risk matrix tool also allows comparison of different risk situations quantitatively by considering the various ensuring consistency to assessing the impact and probability of an event.

Where additional risk investigations measures have been identified through the risk matrix approach, specific hazard, vulnerability and exposure analysis can be undertaken. These methods are also document within the risk analysis section of this policy. At the risk identification stage it is important to consider all hazards, how they interact, their probability of occurrence and their possible impact. Analysis on this scale is referred to as considering "risk scenarios". Risk scenarios are a plausible description of how the future may develop. Scenario building is mainly based on experience from past events, risk matrixes can be used to develop the scenarios when considering the different plausible outcomes.

PPRD EAST 1 Risk Matrix Hazard Analysis

The risk matrix is a visualization tool that relates the two dimensions of a disaster, notably likelihood and impact. They are represented in a graphical format to facilitate the quantitative comparison of different risks. Within each category both impact and likelihood the relative importance should be graded using a qualitative process of considering the impact from previous disasters, acceptable impact levels and information from key experts. A single set of criteria to score the relative likelihoods and impacts to the different hazard risk scenarios originally identified is required to be set, this criterion must be considered consistently across all the different hazards that are being assessed.

[22] (EC Risk Assessment and Mapping Guidelines for Disaster Management (2010) at link https://ec.europa.eu/echo/files/about/COMM_PDF_SEC_2010_1626_F_staff_working_document_en.pdf)

An assessment of the "Likelihood" of the consequence is established. The likelihood is the probability that an event will occur and is given a likelihood number.
The explanation of likelihood of the consequences or probability that a hazardous event will occur is given in Table 6. The table has been developed from understanding the context and realities within the different partner countries.

	Likelihood		Chance per location
	Description	Guidelines	
5	**Almost Certain**	Significant threat that could occur in any time. Immediate remedial action is required to remove or reduce the risk	70%
4	**Probable**	The threat exists and it indicates high probability. Action is required to reduce this risk	50 – 70%
3	**Likely**	The threat exists but the history or expectation of this type of situation indicates occurrence is moderately probable. Action could be taken to reduce this risk but it is unlikely to be cost beneficial	30 – 50%
2	**Unlikely**	A slight threat is perceived from this source but the situation is unlikely to occur. No action is required to reduce this risk, unless the business demands minimal risks	10 – 30 %
1	**Negligible**	No perceived threat exists from this source. No action is required to reduce the risk	<10%

Table 6. **Assessment of the "Likelihood" of the consequence**

Following this the "Impact" of the consequence of an undesired event is established. The impact is the result of an event occurring and is given an event number.
In order to give some indication of the potential impact of various types of risks, use will be made of the internationally recognized measures presented in Table 7.

Impact (I)	Minor - 1	Significant - 1	Severe - 1	Major - 1	Catastrophic - 5
Human					
Economic					
Environmental					
Social					
Political					

Table 7. Indicative impact measures

This information can then be used to develop a risk rating for all of the individual hazards risks identified, this is based on the ratings presented in table 3. For the purpose of this policy the comparison of several risks in one risk matrix is not called a multi risk analysis.

	Relative likelihood				
Relative Hazard Impact	1.Negligible	2.Unlikely	3.Likely	4.Probable	5.Almost certain
5. Catastrophic	Medium	High	Very High	Very High	Very High
4.Major	Medium	High	Very High	Very High	Very High
3.Severe	Medium	High	High	High	High
2.Significant	Low	Medium	Medium	Medium	Medium
1.Minor	Low	Low	Low	Low	Low

Table 8. Risk ratings

6. Flood Hazard and Risk Assessment

This section provides flood hazard maps and flood risk maps explanation in the framework of EUFD. The Flood Hazard Maps and Flood Risk Maps (FHRM) general operational scheme is presented. It contains general information on preparatory stages for FHRM producing:

- Type of floods to be considered
- Type of information needed for the hazard/risk maps
- Kind of hazard and risk maps produced

The data collection, FHM and FRM definition and production procedure are briefly described.
The methodology used by EU Member States and a short overview on development of FHRM by EU Member States is given on the base of the report of European Commission "EU overview of methodologies used in preparation of Flood Hazard and Flood Risk Maps"[23] (2015). The current status in EaP countries of PPRD East2 project is described in this section. The main recommendations on development of FHRM for each country taken taken from Country Profiles of 2015 are presented.

6.1 The Scope of Flood Hazard and Risk Assessment

According to Floods Directive EU Member States should prepare flood hazard maps and flood risk maps (Article 6) at the most appropriate scale for the areas identified under Article 5.1 (APSFR), taking into account also exchange of information between the Countries in case of international basins.
Flood hazard maps shall cover the geographical areas which could be flooded according to the scenarios of: low probability, or extreme event scenarios; medium probability (likely return period ≥ 100 years); high probability, where appropriate. In case of coastal areas where an adequate level of protection is in place, or for areas where flooding is from groundwater sources, the preparation of flood hazard maps can be limited to low probability scenarios.
Flood risk maps shall show the potential adverse consequences in terms of inhabitants potentially affected, economic activities potentially affected, environmental issues and other information.

Once the Preliminary Flood Risk Assessment (PFRA) has been performed, the second phase would be to set-up the definition of Flood Hazard Maps (FRM) and Flood Risk Maps (FRM).

The objective of this phase can be looked at from different points of view depending on the stakeholder considered. The production of FHM and FRM has different aspects:

- technical
- organizational
- political

As for the PFRA also in this phase should be defined the institutions (Figure 4) that:

1. are in charge of coordinating the Flood Hazard and Flood Risk mapping,

[23] (EU overview of methodologies FHRM (2015) at link http://ec.europa.eu/environment/water/flood_risk/pdf/fhrm_reports/EU%20FHRM%20Overview%20Report.pdf)

2. have the basic technical knowledge of managing the Flood Hazard and Flood Risk mapping data eventually available, have the information at local/catchment level in accordance with the requirements of the Flood Hazard and Flood Risk mapping.

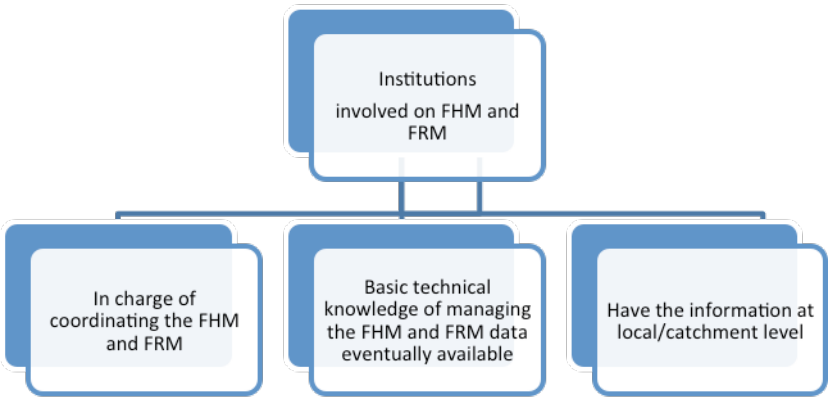


Figure 8. Involved institutions.

6.2 Overview of Flood Hazard and Risk Assessment in EU Member States

After definition of involved institutions in Flood Hazard and Risk Assessment the Operational Procedureon Flood Hazard and Risk Maps development is launched. The Operational Scheme is provided below..

OPERATIONAL SCHEME of Flood Hazard Maps and Flood Risk Maps

Production of Flood Hazard and Maps Flood Risk Maps at National level, using common criteria.
Aspects that should drive the operational procedure:

1. **Type of floods to be considered -** Floods can have various origins depending on the characteristics of the basins and meteorological regime. A decision has to be taken which types of floods should be considered. The origin of floods can be very different, e.g. flooding from the sea, flash floods, ground water flooding. Consider whether flooding from the sea might create serious risks and if so, check whether collected data are sufficient. The same holds for areas where flash floods or floods from ground water occur in a more than accidental way.
2. **Type of information needed for the hazard/risk maps –** This choice depends on the operational use of FHM and FRM. Example of information needed in the full cycle of Disaster Management: prevention/mitigation, preparedness, response and recovery
    - Institutions involved in the prevention and preparedness phase (e.g. in production or application of spatial plans). In this case it is important, between others, to know:
        - areas that can be flooded and
        - water depth that can be reached with its associated its return period, while for
    - Institutions involved in early warning, crisis management plans and emergency management (response and recovery) it is important to know:

- areas that can be flooded,
- scenarios(in terms of planning) and possible reliable estimate (during flood events) about:
  - people involved,
  - possible damages,
  - most sensitive areas ,
  - most effective evacuation strategy.

3. **Kind of hazard and risk maps produced -** On the basis of what reported above, for each scenario (high probability, medium probability and low probability)
   The hazard maps should include:
   a. Inundated area
   b. Maximum water depth
   c. Flow velocity (if it is relevant)

   The risk maps should include (at least):
   a. Number of people living in the potential inundated areas
   b. Economic activities in the potential inundated areas
   c. Industries/Installations subject to relevant risk in the potential inundated areas.

Consider the transboundary basins in order to proper manage a coordinated and homogeneous approach in preparing the FHM and FRM.

Data collection

The development of flood hazard maps and flood risk maps requires a large number of data and information in order to produce flood hazard maps and flood risk maps.
The time needed to produce the maps depends not only on what is available but also on how it is available and on the quality of it.
In order to simplify and shorten the process of data collection a first survey should be done in order to get an overview of the data in terms of availability, quality and homogeneity.
Before the proper production of the hazard maps, a number of general decisions about standards and working methods have to be made:

- Methodology/standards for hazard data production including the definition of the data to be used for hazard mapping for different types of floods (data format and structure), the process of data collection, data submission, data update and storage and the metadata to be provided.
- Technical document describing the risk data to be used, the process of data collection and update (including the description of data format, structure and metadata)
- Technical document describing the final data structure of hazard and risk data and the update process

Flood Hazard Maps definition and production

Flood Hazard Maps shall cover the geographical areas which could be flooded according to the following scenarios:

- Floods with a low probability, or extreme event scenarios;
- Floods with a medium probability (likely return period ≥ 100 years);
- Floods with a high probability, where appropriate.

The following elements shall be shown:

- The flood extent;
- Water depths or water level, as appropriate;
- Where appropriate, the flow velocity or the relevant water flow.

For a first step is recommended to face the fluvial flooding hazard and to make use of:

- a hydrological model to properly assess the routing of precipitation from rainfall to runoff.
- a hydraulic model to evaluated in detail the spatial extensions of floodable areas.

Using this chain it will be possible to model the flood extent, water depth and flow velocity for different scenarios.
The technical aspects how to build hydrological models for the production of Flood Hazard Maps will be presented and detailed during the Capacity Buildings activities.
During the modelling phase the following data have to be collected:

- Topographic maps
- Hydrological data
  - Gauging station (discharge, water levels)
  - Precipitation data
  - Recorded flood extent
- Geometrical data
  - Cross sections
  - Longitudinal profile
  - Digital Terrain Model (DTM)
  - Hydraulic structures (dykes, weirs with operational rules, sills, ….)
- Hydrographical data (watercourse network, gauging station locations, lateral inflows)
- Flood extent of floods in the past (from PFRA)

The accuracy of both the models and the hazard maps can be improved with a better DTM.
When discharge and water depth data are available, a validation phase of the results should be done with local people to see whether the results of modelling can be reliable or not. Satellite images or aerial photographs of past events can usefully support the validation phase.

Flood Risk Maps definition and production

Flood Risk Maps will be developed on the basis of the FHM for the same scenarios. These maps will show the potential adverse consequences associated to flood scenarios and will be expressed in the following terms:

- the indicative number of inhabitants potentially affected
- type of economic activity of the area potentially affected
- other information which can be considers useful for a proper definition of risk.

The information collected should consider the risk receptors. The definition of risk receptors is mainly a political decision and a discussion phase with political level should be made. Once there is an agreement of the risk receptors, the collection of data can start. The procedure should define risk data to be used (including the description of data format, structure and metadata), the process of data collection and its update.

The methodology used by EU Member States

The report of European Commission "EU overview of methodologies used in preparation of Flood Hazard and Flood Risk Maps"[24] (2015) provides a summary information of FHRM in EU Member States.

Sources of floods

According to the report "The most commonly mapped source is fluvial flooding with 25 of the 27 Member States reporting information preparing such maps. The two Member States (Luxembourg and Malta) that did not prepare maps for fluvial sources prepared maps (only) for pluvial flooding.1 Four other Member States also prepared specific maps of pluvial flooding and eight other Member States combined pluvial flooding with other relevant sources (usually fluvial) in their maps. Seventeen of the 22 Member States with a coastline (that had reported), prepared maps of sea water flooding. Only two Member States prepared maps for groundwater floods and six for floods from artificial water bearing infrastructure.

Floods scenarios

All 25 Member States that had prepared and reported medium probability fluvial floods (Luxembourg and Malta only mapped pluvial floods2 and Bulgaria had not yet reported) used a 100 year return period (as suggested by the Directive) or 1% annual exceedance probability for the expression of the probability of flooding: some also used other return periods such as 200 or 300 years. Most Member States that prepared and reported sea water flooding maps also used a 100 year return period or 1% probability for the expression of a medium probability scenario: Ireland used an annual exceedance probability of 0.5% and Italy either 50 or 200 year return period as well as 100 years.

Hazard elements

Most of the 25 Member States that have prepared fluvial flooding hazard maps show flood extents and water depths/levels for all three probability scenarios. The exceptions are Latvia where the publicly accessible maps only show flood extent and Denmark where the flooding probability scenarios are not shown on the maps. Twelve Member States also mapped flow velocity or relevant water flow for all three probability scenarios. Thirteen of the 17 Member States preparing sea water flood maps produced hazard maps covering the two required probability scenarios and included the two required hazard elements. Water depth and flood extent were visualised on the Danish hazard maps but not in relation to any specific scenario. Five Member States also mapped flow velocity or relevant water flow for at least one of the three probability scenarios.

Resolution of maps

26 Member States had maps that had a scale of 1:25,000 or larger, indicating that they should be appropriate for public use. The maps for Hungary had a scale of 1 to 2,000,000 which seems to be inappropriate for public information and awareness purposes. There was no information for Bulgaria which has yet to report.

Mapping of potential adverse consequences

- 25 Member States (excluding BG, LV and PT) reported/showed information on their medium probability risk maps that included the indicative number of inhabitants potentially affected;
- 27 Member States (excluding BG) reported/showed information on the potential adverse consequences on economic activity from medium probability floods;

[24] (EU overview of methodologies FHRM (2015) at link http://ec.europa.eu/environment/water/flood_risk/pdf/fhrm_reports/EU%20FHRM%20Overview%20Report.pdf)

- 25 Member States reported/showed information on the potential adverse consequences on the environment from medium probability floods: Bulgaria has not reported as of yet, and Denmark and Malta indicated that environmental consequences were not applicable. Potentially affected Industrial Emission Directive installations were shown/reported by 25 Member States for medium and/or low probability floods and the potential effects on Water Framework Directive or other Protected Areas by 14 Member States;
- 13 Member States reported potential adverse consequences on cultural heritage: 7 others have also included cultural heritage features on their national maps.

Preparation of flood hazard and flood risk maps in international UoMs

There seems to have been an exchange of information in 15 Member States (AT, BE, DE, EL, ES, FI, HU, IE, LT, LU, NL, PL, RO, SE, UK) sharing river basins, for most, if not all, of their shared basins. There was no information reported for six Member States (CZ, FR, IT, LV, PT, SI) with shared basins, for two others (DK, HR) the reported information was not clear and four Member States (CY, EE, MT, SK) indicated that they had no shared flood risk areas. Bulgaria had not reported. International River Commissions play a significant role in cases where information has been exchanged.

Consideration of the effect of climate change in the preparation of maps

16 (out of 27) Member States have taken climate change into account when preparing their flood maps; there was no information for Bulgaria as it had not reported. For example, in Sweden the medium probability flood maps for river and lake flooding took account of predicted changes in climate to 2098. In Denmark, three future climate change scenarios were included in preparing medium probability maps for river and coastal flooding: for example, a 30 cm increase in sea level was considered.

Conclusion

There are several gaps in the availability of information on some Member States' flood maps. Bulgaria has not reported as of yet, Greece has only reported for one Unit of Management and data from Croatia, Malta and Portugal has yet to be added to the WISE database.

Twenty six Member States share river basins with another Member State. It is not clear from the available information as to whether there are shared flood hazard and flood risk areas within these shared basins."

6.2.1 Good Practices on Flood Hazard and Risk Assessment in selected EU Member States

In this section are provided three overview of FHRA of Germany, Ireland and Italy. Reported by EU Member States good practices represent short description of different approaches and methodologies used for development of FHRA.

As in section 5.2.1 a country overview is divided into four sections: General description, Methodology, Outcomes, and References. AAA

Germany Flood Hazard and Risk Assessment

General Description

The EU Floods Directive (2007/60/EC) was transposed into German national law by means of the Federal Water Act (Gesetz zur Ordnung des Wasserhaushalts (Wasserhaushaltsgesetz) – WHG) of 31 July 2009 (Federal Law Gazette (BGBl.) I p. 2585). The Act is in force from 1 March 2010. Section 74 of the Act contains provisions on the establishment of "Hazard Maps And Risk Maps".

The document "Recommendations for the Establishment of Flood Hazard Maps and Flood Risk Maps" was adopted at the 139th LAWA General Meeting in Dresden on 25/26 March 2010.

The present document contain standards that allows the process of Flood Hazard Maps and Flood Risk Maps definition to be compliant with the minimum requirements for FRMD. The aim is to ensure that the content and design of the maps are standardized as far as possible, thus ensuring that the set of maps produced has nationwide coherence. Some deviations may be necessary, however, in relation to the coordination process for international river basins.

Furthermore, there are numerous possible applications for Flood Hazard and Flood Risk Maps, as it is evident from the maps already produced in some of the federal states (Länder). The precise content of the maps depends on the intended use and is tailored on users' requirements.

Methodology

In order to comply with the provisions of the FRMD by the deadlines specified, it is recommended to assign to each Germany's federal states (Länder) a lead agency with responsibility for preparing the Flood Hazard and Flood Risk Maps and initiating such preparation in a timely manner.

The Flood Hazard and Flood Risk Maps and possible conclusions to be drawn from them will then also form part of the Flood Risk Management Plans.

The Flood Hazard Maps depict the scenarios that could occur under current conditions. The use of up-to-date hydrological data means that climate change impacts which have already occurred are incorporated into the maps. Future trends, as far as they can be predicted, can be considered in the Flood Risk Management Plans.

Flood Risk Maps are prepared for the same flood scenarios on the basis of the Flood Hazard Maps. They should show, based on the flood hazards maps (extent of flooding), the adverse consequences of flooding.

For FHM, technical criteria concern the development and compilation of data (hydrology, topography, roughness etc.) that form the basis for the production of the maps, the choice and development of the hydraulics computational models (1D, 2D or combinations) and data management arrangements.

FRM includes flood hazard data, available from the FHM together with the following information:

- number of inhabitants potentially affected (number of inhabitants in each municipality, land use data);

- type of economic activity (housing and mixed use, industrial and commercial areas, areas of a special functional character, all types of object of relevance to transport, agriculture, forestry, all other object types, all water-related object types);
- installations pursuant to Annex I of Council Directive 96/61/EC (concerning integrated pollution prevention and control - IPPC Directive- that are located in inundation areas);
- protected areas identified in Article 7 of the EUWFD;
- the inclusion of sites of particular cultural relevance in the FRM is not a requirement of the FRMD.

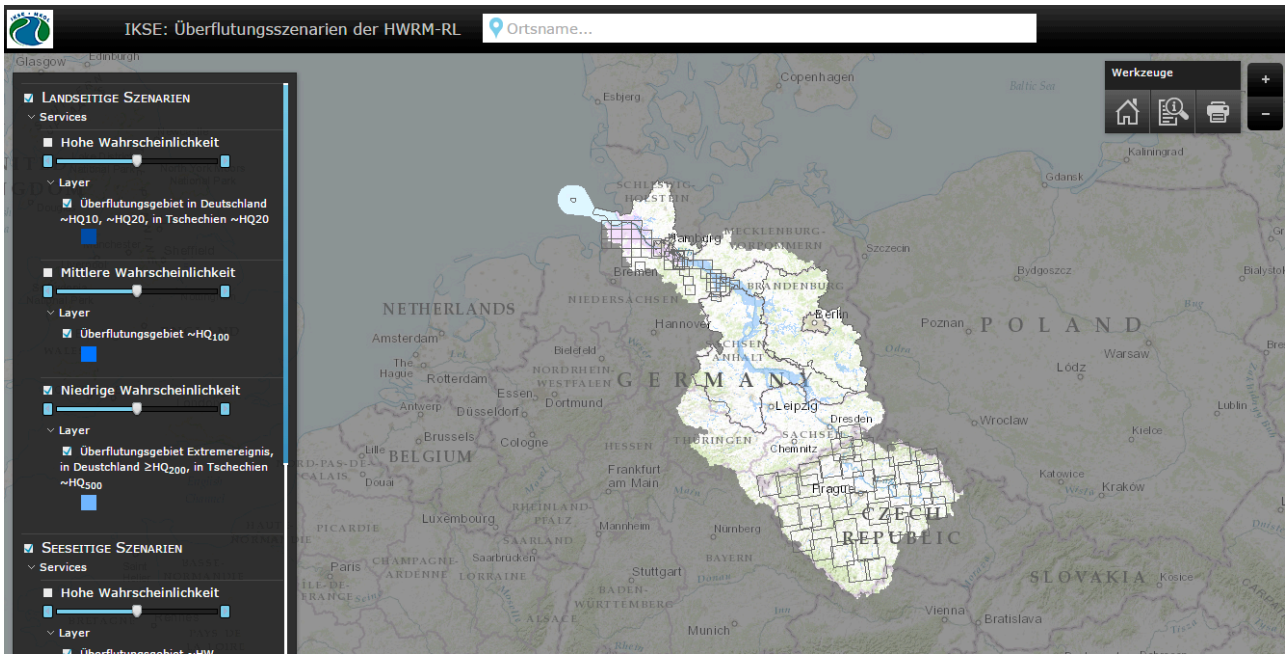
The following recommendations are intended to facilitate the standardized design of the FHM and FRM throughout Germany and should be followed unless the federal states (Länder) apply different procedures.

1. Data processing and map structure –GIS should be used to collect, customize and update basic flood hazard and flood risk map data, as well as to produce the maps. These data should be archived without map sheet divisions or administrative boundaries and as far as possible are to be described in terms of the relevant meta-data, namely source, accuracy, scale, and date of last update. the largest format used should be DIN A0 standard. Each map should meet basic cartographic standards (map title, legend, scale etc.);
2. Content design
    a. FHM – for each scenario, the flood extent (area), water depths and where appropriate, the flow velocity or the relevant water flow should be shown in a separate map. Are reported also recommendations on the scale of colour to use for water depth in both cases of systems without technical flood protection and in protected systems. Other technical details are also specified;
    b. FRM – include FHM but also other diverse area and point information. A FRM should be made for each return period considered. The variables to include in the map and the legend to use are also described.

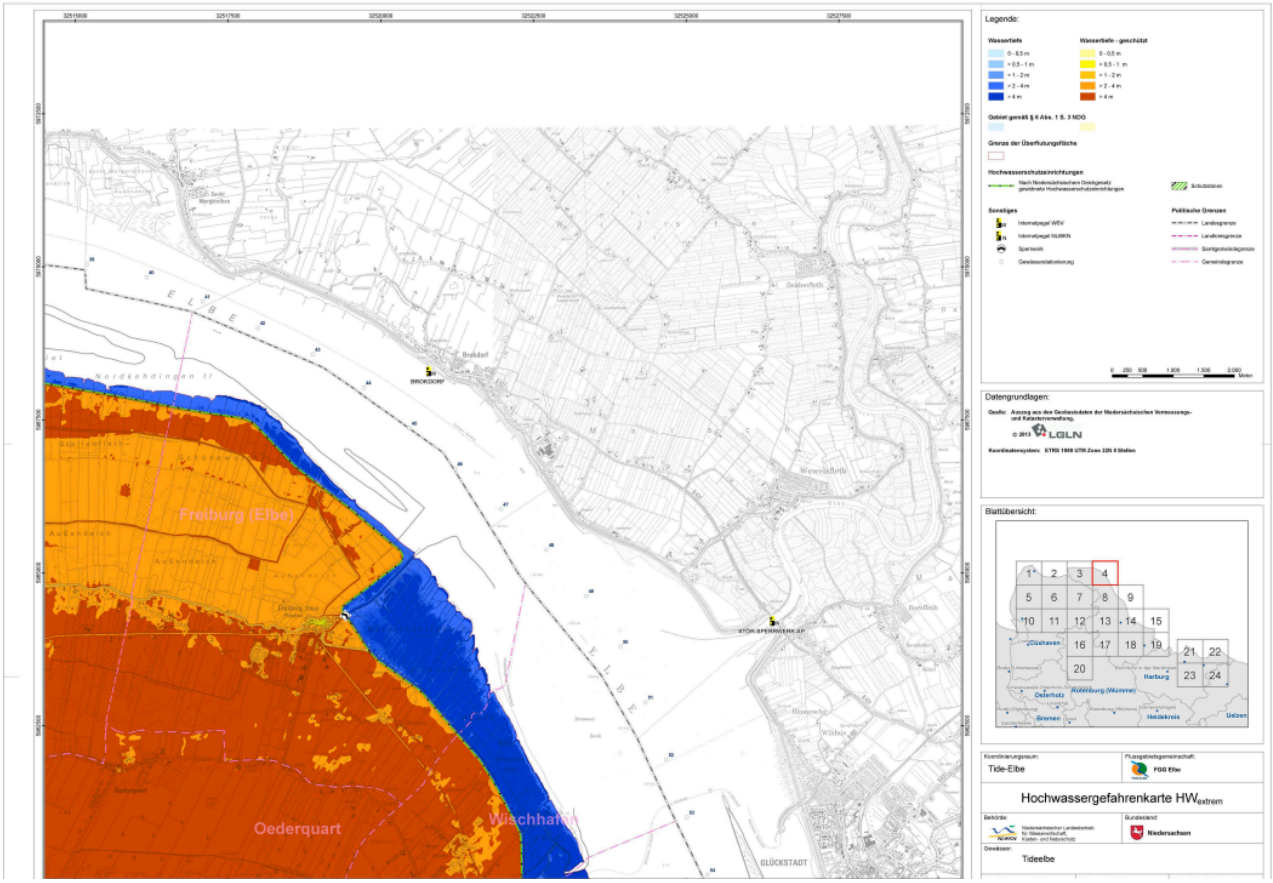
FHM should preferably be produced with a scale of 1:2,500 up to 1:10,000. The maps are available to the public.

Outcomes

The geoportal of International Commission for the Protection of the Elbe River (IKSE MKOL) provides detailed risk maps of territory in PDF format (See Figures below)



Geoportal International Commission for the Protection of the Elbe River (IKSE MKOL) interface.



The detailed risk map

References

IKSE-MKOL Geoportal	http://geoportal.bafg.de/mapapps/resources/apps/IKSE_DE/index.html?lang=de
Recommendations for the Establishment of Flood Hazard Maps and Flood Risk Maps	http://www.lawa.de/documents/LAWA_HWGK15062010_Text_Germany_ENG_f72.pdf

Ireland Flood Hazard and Risk Assessment

General description

The Office of Public Works (OPW) is the lead State body for the coordination and the implementation of the Government policy on the management of flood risk in Ireland. The OPW is also the national authority for the implementation of the EU Directive on the Assessment and Management of Flood Risks (2007/60/EC). OPW works in close partnership with all Local Authorities in delivering the objectives of the Catchment Flood Risk Assessment and Management (CFRAM) Programme.
The CFRAM Programme represents a national strategy for the reduction and management of flood risk in Ireland from the medium to long-term. The Programme represents a core components of the National Flood Policy, adopted in 2004, and of the requirements of the EU Floods Directive.
The Programme is composed of three main consultative stages:

- 2011 Preliminary Flood Risk Assessments.
- 2014 Flood Hazard Mapping (This involves the mapping of areas that are at significant risk from flooding. The maps will show the extent of flooding likely, how deep the water could get and how fast the water will flow);
- 2015 Flood Risk Management Plans.

Methodology

There is a long history of flooding in the South Western River Basin District (RBD) with Cork City, Bandon, Mallow, Skibbereen, Clonakilty and Fermoy among the most vulnerable areas to flooding. The Office of Public Works and its partners, Cork City Council and Cork County Council, have undertaken a catchment-based flood risk assessment and management study of the Lee Catchment (River Lee, its tributaries and Cork Harbour) – the Lee CFRAM Study. The Lee CFRAM Study is the primary pilot project for a new national approach to flood risk management under the National CFRAM Programme.
The object of the programme is to create accurate flood maps for areas at significant risk from flooding, develop plans to manage flood risk on a catchment-wide scale as well as promote the active participation of the public in addressing flood risk.
The data for developing flood risk maps include:

- Records of past flood events;
- Rainfall records throughout the RBD;
- Runoff records from river level gauges throughout the catchment;
- Detailed survey information on the depth, width and slope of all the rivers that contribute to flooding in the RBD;
- High resolution floodplain maps.

The Lee CFRAM Study is now complete. The main outputs from this study are flood maps.

Predictive flood maps are a key output of the Lee CFRAM Study. The flood maps provide representations of areas that are estimated to be inundated at some point during a flood event (caused by either river overtopping or tidal overtopping). These maps are derived using information from detailed hydrological analysis and numerical hydraulic river/estuary models. The predictive flood maps, are categorized into groups titled 'urban area' and 'rural area' maps. The urban area maps are at a larger scale (more detailed) than the rural area maps. The rural area maps include the areas covered by the urban area maps and are at a smaller scale.

There are four map types available for viewing - flood extent, depth, velocity and hazard maps. Flood extent maps represent the areas that are estimated to be inundated by a flood event of a given probability of occurrence.

- Flood extent maps are available for both existing conditions and a projected future scenario, where the maps for future scenarios include allowances for projected future changes in both climate and land use. These maps also show water levels, flows and defended areas.
- Flood depth maps illustrate the estimated flood depths for areas inundated by a flood event of a given probability of occurrence. Depth maps are available for a number of annual exceedance probability (AEP) events. The AEP is the estimated likelihood of a particular magnitude flood occurring or being exceeded in any given year. Thus, a 1% AEP event represents an estimated flood event which has a 1% (or 1 in 100) chance of occurring or being exceeded in any given year.
- Velocity maps illustrate the estimated speed of the flood water for a flood event of a given probability of occurrence. Velocity maps are available for a number of AEP events (the same as described above for Flood Depth maps).
- Hazard maps show the estimated harm or danger to which people may be exposed for a flood event of a given probability of occurrence. Hazard maps are also available for a number of AEP events.

Flood risk is a combination of the probability and degree of flooding (the 'hazard') and the damage caused by the flood (the 'consequences'). Flood hazard can arise from a range of sources of flooding, the CFRAM Study addresses the following sources: Rivers (fluvial) Sea (coastal and tidal).

The following four risk receptor groups are vulnerable to the potential adverse consequences of flooding: Society; Environment; Cultural; and Economy.

The Social Flood Risk shall be assessed, mapped and reported upon using four methods and indicator sets:

- the location and number of residential properties
- the location, type, and an indicator of vulnerability and number of potentially high vulnerability sites, such as residential homes for children, the elderly or disabled, etc.
- the location, type, and an indicator of vulnerability and number of valuable social infrastructural assets, such as fire stations, police (Garda) stations, ambulance stations, hospitals, government and council buildings, etc.
- the location, type, and an indicator of vulnerability and number of social amenity sites, such as parks, leisure facilities, etc.

The Flood Risk to the Environment shall be assessed,mapped and reported upon using three methods and indicator sets:

- the location, type, and an indicator of vulnerability and number of installations referred to in Annex I to EU Directive 96/61/EC (1996) concerning integrated pollution prevention and control and other significant potential sources of pollution.

- the location, extent, nature and an indicator of vulnerability of areas identified in the Water Framework Directive (EU Directive 2000/60/EC)
- the nature, location, and an indicator of vulnerability and areas of other environmentally valuable sites, such as SACs.

The Flood Risk to cultural heritage shall be assessed and mapped and reported upon using one method and indicator set: location, type, an indicator of vulnerability and number of sites or assets of cultural value.

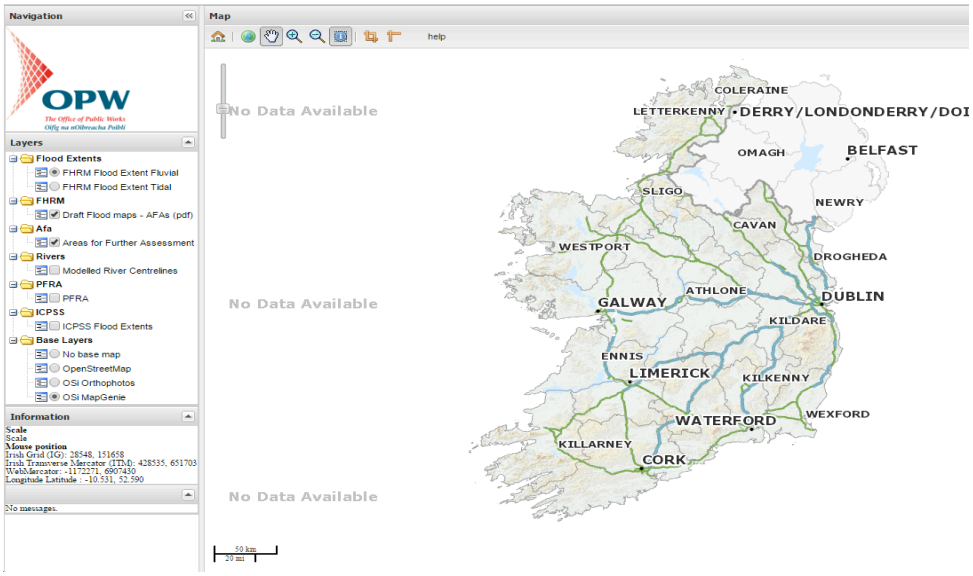
The Flood Risk to the Economy shall be assessed and mapped and reported upon using four methods and indicator sets:

- the location, type (residential and classifications of non-residential) and numbers of properties, with associated frequency-depth-damage information based on property type
- the density of economic risk expressed as annual average damage (euro / year) per unit area (e.g., per 100m or 500m square)
- the location, type, and an indicator of vulnerability and number (and / or lengths) of transport infrastructural assets, such as airports, ports, motorways, national and regional roads, rail, etc.
- the location, type, and an indicator of vulnerability and number of utility infrastructural assets, such as electricity generation and sub-stations, water supply and treatment works, natural gas and oil facilities, important telecom interchanges, data repositories, etc.

Indicators of vulnerability are typically a categorization of vulnerability (e.g., very high to very low) or, a numerical or economic consequence or depth-consequence curve in the event of flooding. The indicators of vulnerability are to be provided by OPW for each type of social, environmental, cultural and economic risk receptor.

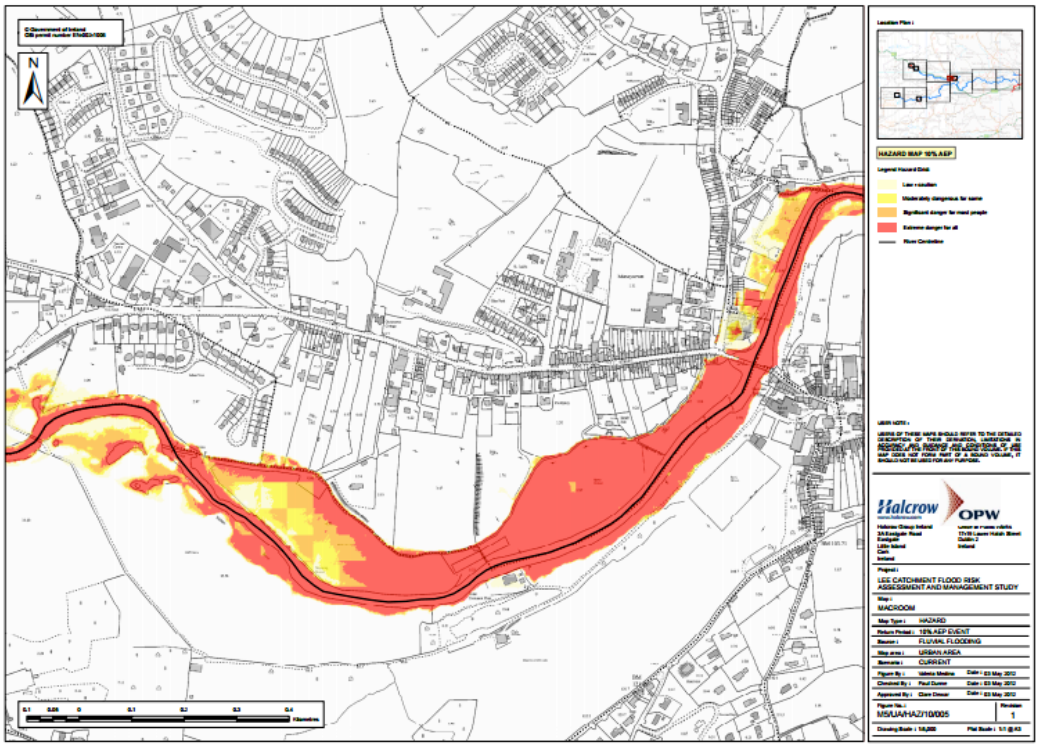
Outcomes

The OPW viewer at national level provides Flood Extent Maps, Flood Depth Maps and Flood Risk Maps. Maps showing the Specific Types of Economic Activity across Units of Management vary in scale depending on the size of each Unit of Management.



The Office of Public Works FHRM viewer at national level

On Figure below is provided Flood Hazard Risk map of Macroom city, which shows the estimated danger to which people may be exposed for flood event of a given probability of occurrence.



Macroom city Flood Hazard Map 10% AEP - 1

References

Catchment Flood Risk Assessment and Management (CFRAM) Programme	http://www.cfram.ie/
Lee Catchment Flood Risk Assessment and Management (CFRAM) study	http://sw.cfram.com/?page_id=987
Lee CFRAM Study Predictive Flood Maps	http://www.lee.cfram.com/maps2.html

Links to Lee CFRAM study predictive flood maps	http://www.opw.ie/en/leecframs/floodmaps/maps
More information and details on South Western RBD CFRAM Study are provided in Reports (PDF) for each UoM	http://sw.cfram.com/?page_id=79
OPW FHRM guidance	http://maps.opw.ie/fhrm/guidance/
OPW Viewer of FHRMs at national level	http://maps.opw.ie/fhrm/viewer/
Predictive flood maps for Baile Mhic Íre town (Ballymakerra)-Baile Bhuirne county (Ballyvourney)	http://sw.cfram.com/?page_id=987
Technical Hydrology and Hydraulics and Flood Mapping Reports are available through the National CFRAM Programme website	www.cfram.ie

Italy Flood Hazard and Risk Assessment

General Description

The Ministry of Environment, Land and Sea Protection (MATTM) informed the European Commission that Italy would made use of the transitional measures, as required by the art. 13.1b of Directive 2007/60/EC, and therefore would not carry out the preliminary flood risk assessment referred to in Article 4, having decided, before 22 December 2010, to draw up hazard and flood risk maps and establish management plans for flood risk in accordance with the relevant provisions of the Floods Directive.

This does not exclude the need to prove, upon request of the European Commission, that all the steps required by art. 4 of the Floods Directive, have been considered in the identification of areas at potential risk where are focused the current mapping activities.

Methodology

The Legislative Decree no. 49/2010 state that the flood hazard maps and flood risk maps, should be prepared in scale preferably not less than 1: 10.000 and, in any case, not less than 1: 25.000. As well as the DPCM 29/09/1998 required a representation scale of not less than 1: 25.000 for both the perimeter of the inundation areas (1:50.000 only for the most severe scenario in protected areas by surmountable embankments for a return time T = 200 years) and for the identification of elements at risk.

Flood Hazard Mapping

The reporting of hazard maps, according to EU Floods Directive 2007/60/CE, is based on a series of textual information and on geographic information (e.g. shape files and polygons of the flood areas). Text information for the reporting of flood maps to be provided by XML files or ACCESS tables, whose contents and relationships are defined. They consist in a series of SUMMARY TEXTs, in the description of the type of floods and possibly of the features and mechanisms associated with them and in the indication of the probability or return period associated to the scenario of hazard.

The summary information includes:

- the extension of flood (including the resolution of digital models);
- the likelihood of flooding or return period;
- height or water levels;
- speed and / or flow rates (where appropriate);

The geographic information is represented by polygon type and with an extension of the flood associated to each flood scenario (high, medium, low likelihood of flooding). The information of XML files (or tables db access) are associated uniquely through alphanumeric codes to individual polygons, that are the features of the shape file. The contents and format of the data for the reporting of hazard maps are described in detail in the document "Notes on the completion of Access Database compliant for XML SCHEME reporting of Dir. 2007/60 / EC Art. 6: Flood Hazard and Risk Maps" published in the restricted area within the section Floods Directive 2007/60.

The Legislative Decree no. 49/2010 states that the hazard maps, in addition to the height or water level, should report also the discharge and the velocity (mandatory). Furthermore, in line with what contained in the Prime Ministerial Decree of 1998 each probability scenario is defined by a specific interval of return period. In Table the information required by the EUFDEUFD and the Italian legislation on the definition of scenarios of probability, expressed in terms of return period, is compared.

Probability	Directive 2007/60/CE	Legislative Decree 49/2010	Prime Ministerial Decree 1998
Low (extreme events)	-	T ≤ 500 years	300 ≤ T ≤ 500 years
Medium	≥ 100 years	100 ≤ T ≤ 200 years	100 ≤ T ≤ 200 years
High	-	20 ≤ T ≤ 50 years	20 ≤ T ≤ 50 years

Table A. Return periods (T) for each scenario of probability.

In the Legislative Decree 49/2010 is required that in the hazard maps should be highlighted the areas where can be experienced flooding with high content of transported sediments and debris flows. Given the high frequency of these phenomena in the whole country, as well as related effects in terms of direct and indirect damages, the Italian legislation intend to include them in the definition of floods.

The EU Floods Directive foresees that climate change effects on hydraulic risk should be counted, based on observations and weather-hydrological and hydraulic models.

ISPRA Institute developed a Methodology[25] (2013) for updating hazard and risk maps. Two matters are taken into consideration. The first one is related to the graphic representation, both related to the heights and to the water velocity. The second one concerns the significance of the values calculated by one-dimensional hydrodynamic or quasi-two-dimensional models, or derived from methods of historical inventory / geomorphologic.

[25] http://www.isprambiente.gov.it/it/pubblicazioni/manuali-e-linee-guida/Proposta-metodologica-per-l-aggiornamento-delle-mappe-di-pericolosita-e-di-rischio/leadImage/image_view_fullscreen

Embankments

The methodology recommends to include the embankments in hazard management plans and to provide a value of security in respect of occurrence of frequency of breaks of embankments of II category (art. 3 R.D. 523 25/07/1904 e s.m.i.) and if possible of III category (art. 4 comma 10ter Legge 677/1996). In case of absence of information recommends to provide at least the reliable information on frequency of breaks and thematic maps with reference on comma 5d art. 6 of EYFD (comma 5f del D.Lgs. 49/2010 – "other useful information of Member States").

Representation of flood water heights and velocity

For what concerns the water level (h) mapping, it is proposed to use a scale of blue defined by a grouping of the height values into 5 classes (Table) with variability interval constant and equal to 0.5 m.

h (m)	Colour	R	G	B
h < 0.5		182	237	240
0.5 ≤ h < 1		116	180	232
1 ≤ h < 1.5		31	131	224
1.5 ≤ h < 2		29	68	184
h ≥ 2		9	9	145

Table B. Scale of colours for the representation of water heights (h).

In cases where it is available only the indication of exceeding or less than a certain threshold value, it is proposed the use of only two levels of colours that share that value, taking care to show the assumption represented in the legend. See Table below.

h (m)	Colour	R	G	B
0.5 ≤ h < 1		116	180	232
1 ≤ h < 1.5		31	131	224

Table C. Example of colour scale for the representation of water level (h) with respect to a threshold value.

The representation of the water velocity is mandatory according to the Italian legislation. The visualization of the two overlapping layers (water level and velocity) is proposed to display by means of a screening diagonal (only for those areas in which the value exceeds a certain threshold), which maintains transparency in the visibility of underlying layers of water level (see an example below).

Figure A. Example of the overlap between layers of water heights and layers of speed

Significance and uncertainty of velocity and hydrometric heights

The one-dimensional and quasi-two-dimensional models pose the problem of "distribution" of values calculated at certain sections. The values estimated / calculated should therefore be associated in the

subsequent phases of study (analysis of the risk of flooding and residual risk assessment) with a level of confidence (uncertainty)which characterizes them.

Areas subjected to flooding with a high content of transported sediments and debris flows

For flood events with high content of transported sediments, with or without characteristics of debris flow, it is important to identify at least three hazard levels (high, medium and low).

Flood Risk Mapping

The ISPRA Methodological Proposal[26] defines the methodology for the damage evaluation. The significance and assessment of damage are based on (i) the intensity of the event (ii) the social, cultural, economic and environmental exposure associated with the item.

Exposed elements:

a) *The indicative number of inhabitants potentially affected*

The assessment of the number of inhabitants should be carried on by intersecting the census sections with the polygons of the flooding areas and, in case of partial intersection, calculating the number of people potentially affected as the total number of inhabitants assigned to the census section multiplied by percentage of the affected area.

a) *Infrastructure and strategic structures (highways, railways, hospitals, schools, etc.)*

The information downloadable from websites of national services or obtained from public bodies.

b) *Environmental heritage, historical and cultural interest in the floodable area.*

The data of this category is contained by the Italian Ministry of Heritage and Cultural Activities (MIBAC), possibly supplemented by regional and provincial sources.

Categorization of exposed elements

Italian law identifies four categories of exposed elements for risks maps: population, economic activities, cultural heritage and archaeological and environmental assets.

a) Classification of Economic Activities in the European Community –source NACE, Revision 2;

b) Classes of land use – the source CORINE Land Cover at national and local level (Table);

ID	Classes of land use and sources of data
1	Residential (includes all elements related to the urban fabric other than those referred to in point 3,4,8,9)
2	Commercial (including craft) do not come under category 1 and industrial (including mining areas)
3	Hospitals, health care, social worker, (hospitals, nursing homes, homes for the elderly, disabled, handicapped, etc ..), schools and universities
4	Buildings home of essential public services (municipalities, prisons, barracks, prefectures, etc .., not falling under categories 1 and 3)
5	Specialized agricultural land (agricultural land arable, permanent and heterogeneous)
6	Agricultural unskilled (wooded areas, meadows, pastures)
7	Recreational tourism (camping sites, beaches, ski slopes, cinemas, theaters, multipurpose centers, sport fishing, etc., Do not come under category 1)

[26] http://www.isprambiente.gov.it/files/pubblicazioni/manuali-lineeguida/MLG_82_2012.pdf

8	Communication networks and transportation primary (airports, ports, highways, freeways, Regional Roads, Railways). MATTM National Geoportal: http://wms.pcn.minambiente.it/ogc?map=/ms_ogc/wfs/Rete_stradale.map http://wms.pcn.minambiente.it/ogc?map=/ms_ogc/wfs/Rete_ferroviaria.map
9	Communication networks and secondary transport (roads Provincial and Municipal). MATTM National Geoportal: http://wms.pcn.minambiente.it/ogc?map=/ms_ogc/wfs/Rete_stradale.map
10	Technological networks and services (supply gas, electricity, water, sewage, telephone lines, etc., Do not under category 1)
11	Structures and systems to support network communications and transport, technological and service (buildings and structures airports and ports, railway stations, service areas, parking lots, power plants, substations, reservoirs, water purifiers, etc., Do not under category 1)

Table D. Classes of land use, source Corine Land Cover

c) Information layer related to environmental component (Table);

ID	Classes of land use and sources of data
12	Landfills, waste treatment plants, wastewater treatment plants, which could be important sources of pollution in case of flooding (not falling into those referred to in paragraph 13)
13	Installations listed in Annex I of the Legislative Decree n. 59 of February 18, 2005 http://cart.ancitel.it/index.html?progetto=32598B49-3B4C-4843-A6A6-ED943A2AEE14&map=EEC7E870-CA34-6140-9BA8-1F85DE09C552
14	Protected areas identified in Annex 9 in Part III of Legislative Decree No. 152 of 2006. National Information System for Water Protection Italian (SINTAI) - Ispra; Management Plans

Table E. Information layer related to environmental component

d) Information layer related to cultural and archaeological heritage components (example in Table).

ID	Classes of land use and sources of data
15	Assets of historical-cultural and archaeological heritage

Table F. Layer of cultural and archaeological heritage components

Determination of damage

The analysis of the damage (D) is made according to the four main categories specified by the legislation: population (Dp), economic activities (De), cultural heritage and archaeological (Dc), environmental goods (Da). In addition, each component of damage is assessed in the individual classes of land use. It is assumed that an event of given intensity can cause, against an exposed element, a damage / total loss (1), a partial damage (0 ÷ 1) or no damage (0).

Significance and assessment of damage

a) The indexes of damage associated with people are provided in Figure . The determination of the damage on the population is analyzed according to two components: the vulnerability associated to the flood intensity and vulnerability and exposed value expressed in relative terms.

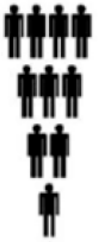
Simbolo 1	Simbolo 2	Numero abitanti
		> 5000 500 – 5000 50 – 500 < 50

Figure B. Examples of representation of the population concerned

5 classes of population density are identified according to Table below and to each of them is assigned a weight factor (density factor).

Class limits (inhabitants / km^2)	Density factor
1 – 40	0.9
40 – 80	0.93
80 – 140	0.95
140 – 320	0.98
>320	1

Table G. Classes of population density (ref. Classes ISTAT 2001 census).

Table reports, for each land use class, a hypothesis regarding the duration of the human presence in the element of the territory concerned. The final value of the exposure associated to the population will be given by the product of the two factors of population density and duration.

ID Classes of land use	Class name of land use	Estimated time (hours)	Duration factor
1	Residential	24	1
2	Commercial and industrial	12	0.5
3	Hospitals, health care, social care, schools and universities	24	1
4	Headquarters building of essential public services	24	1
5	Specialized agricultural	4	0.2
6	Agricultural unskilled	2	0.1
7	Recreational tourism	10	0.4
8	Communication networks and primary transport	24	1
9	Communication networks and secondary transport	12	0.5
10	Technological networks and service	-	-
11	Structures and systems to support network communications and transport, technological and service	8	0.3

Table H. Example for allocation of the duration factor (for land-use classes) based on the permanence of the population

b) The damage associated with economic activities

- for all classes of land use that are characterized by the presence of buildings, the damage is assessed in relation to buildings and goods contained therein;
- the damage for agricultural areas is linked to the loss of the crop and, for higher values of water level and velocity, to the buildings and goods contained therein;

for classes of land use corresponding to the infrastructure the damage evaluation is related to the inability to use the infrastructure and therefore the interruption of service. This can occur with or without structural damage to critical infrastructures (simple flooding or destruction of the property).

Vulnerability associated to economic activities

The 3 categories of damage correspond respectively to:

- damage from simple flooding: damages similar to those caused by natural flood low speed, with no immediate structural damage;
- structural damage partial moderate damage, such as windows and doors thrown to the ground and minor damage to the main structural elements of the buildings;
- total destruction - total collapse or serious damage to structures requiring demolition and reconstruction.

The value exposed associated with economic activities

It is necessary to define a scale of relative values taking into account the costs of recovery, of non-production, of failure to use the service, etc. Table lists the names of the fields related to the variable census ISTAT "Census of Population and Housing".

ID class land use	Classes of land use	Relative value
1	Residential	1
2	Commercial and industrial	0.7
3	Hospitals, health care, social care, schools and universities	1
4	Headquarters building of essential public services	1
5	Specialized agricultural	0.3
6	Agricultural unskilled	0.4
7	Recreational tourism	1
8	Communication networks and primary transport	1
9	Communication networks and secondary transport	0.5
10	Technological networks and service	1
11	Structures and systems to support network communications and transport, technological and service	1

Table I. Example for allocation of economic value relative to the various classes of land use.

c) The damage associated with the presence of cultural heritage;
At present the relevant information for establishing a specific vulnerability of individual assets depending on the characteristics of the flood is not available. The differentiation by type (museum, library, historic building or monument, archaeological site, etc.) is however difficult For this reason when overlapping the flood areas with the layer of " cultural and archaeological heritage " is used Dc = 1 for the assets in floodable areas without taking into account the water level and the flow velocity. .

d) The damage in terms of environmental component;

The contamination is caused by three main sources: industry, human waste / animals, stagnant water spilled. Open spaces refer to areas with natural environment used for activities outdoor recreation, and

tourist attractions such as nature reserves. The approach to be proposed is to use a layer of Protected Areas.

Determination of risk

a) Specific risk - comes from the combination of damage and probability for 3 scenarios hazard, normalized to the maximum specific risk.

Total risk - to assess the risk total is necessary for each scenario of hazard overlap the 4 grid of damage: $D_i = max(Dp_i; De_i; Dc_i; Da_i)$. Calculating the value of Specific Risk (R_i) with the same procedure, the class of risk will be assigned as reported in Table .

Class – Risk Definition	Values R_i	Color	R	G	B
Moderate (R1) for which damage to social, economic and environmental heritage is marginal	$0 < R_i \leq 0.25$		245	245	0
Average (R2) for which is possible minor damage to buildings, infrastructure and environmental assets, that do not affect safety of persons, stability of buildings and functionality of economic activities	$0.25 < R_i \leq 0.50$		245	122	0
High (R3) for which are possible problems for safety of people, functional damage to buildings and unavailability of infrastructure, interruption of functionality of socio-economic activities and substantial damage to environmental heritage	$0.50 < R_i \leq 0.75$		200	0	0
Very High (R4) for which it is possible the loss of life and serious injury, serious damage to buildings, infrastructure and environmental heritage, destruction of socio-economic activities	$0.75 < R_i \leq 1$		112	48	160

Table J. Ranges of values of R_i and attribution of risk.

The contents and formats of the data to be provided for the reporting of the risk maps are described in detail in the "Notes on the completion of Access Database compliant to the SCHEME for the reporting of Dir. 2007/60/EC Art. 6: Flood Hazard and Risk Maps".
The Legislative Decree 49/2010 lists in more detail the categories of elements at risk adding to those given in the Directive further two categories (infrastructure and cultural heritage).. The list of elements at risk considered is reported below:

- indicative number of inhabitants potentially affected;
- infrastructure and strategic structures (highways, railways, hospitals, schools, etc.);
- environmental, historical and cultural heritage of relevant interest present in the area potentially affected;
- distribution and type of economic activities in the area potentially affected;
- classes of land use and sources of data;
- installations listed in Annex I of the Legislative Decree 18 February 2005 n. 59, that may cause accidental pollution in case of flooding;
- potentially affected protected areas identified in Annex 9 in the third section of the Legislative Decree n. 152 of 2006;

other information deemed useful by the authorities of the basin district, like the flood-prone areas with high volume of sediment transport and debris flows or information on sources of pollution.

Outcomes

The CNR-IRPI of Perugia, commissioned by the Department of Protection, has adapted the catalogue historical flood (AVI) to the formats required by the European Commission for the cadastre of flood events, integrating it with additional information relating to major flooding that occurred from 2002 to 2011. This allows to have a uniform database throughout the national territory.

References

ISPRA Institute developed a Methodology (2013) for updating flood hazard and risk maps	http://www.isprambiente.gov.it/it/pubblicazioni/manuali-e-linee-guida/Proposta-metodologica-per-l-aggiornamento-delle-mappe-di-pericolosita-e-di-rischio/leadImage/image_view_fullscreen
Methodological Proposal for Updating Hazard and Risk maps, ISPRA, Italy, 2012	http://www.isprambiente.gov.it/files/pubblicazioni/manuali-lineeguida/MLG_82_2012.pdf
The layer "Land use - Corine Land Cover 2006" is available on the National Geoportal MATTM and accessible by Web Feature Service (WFS)	http://wms.pcn.minambiente.it/ogc?map=/ms_ogc/wfs/Corine_Land_Cover2006.map
The repository of exposed elements National Geoportal of the Ministry of Environment	http://www.pcn.minambiente.it/GN/

6.3 Current Status of Flood Hazard and Risk Assessment in Partner Countries

In Table 6 are provided main recommendations (PPRD East2 Country Profiles, 2015) are summarised for each partner country. The current status on FHRM is described in each paragraph.

EaP Countries	define common methodologies and techniques for FHRM at national level, compliant with EUFD	elaborate flood hazard and risk mapping for all unit of managements starting from a pilot basin	implement a training/capacity building programme for National institutions	Aditional
Azerbaijan	**V**	**V**	**V**	
Armenia	**-**	**-**	**V**	
Belarus	**-**	**-**	**V**	**Fund national scale initiative**
Georgia	**V**	**-**	**-**	**Application of methodology in Kura and Rioni pilot basins**
Moldova	**V**	**-**	**V**	**-**
Ukraine	**V**	**-**	**V**	**-**

Table 9. **Recommendations on FHRM development in EaP region**

ARMENIA

In Armenia Flood Hazard and Flood Risk mapping have been both carried out during last few years, nevertheless the approximation level to EUFD is still quite low. The flood hazard mapping by National Academy of Sciences, Institute of Geological Science (NAS IGS) is not compliant with the detail level required by EUFD and have no directly relation to return periods (i.e., probability of occurrence), which is one of the main points of EUFD.

During PPRD East Programme Phase 1 the NAS IGS has developed a nation-wide mapping of the flood hazard. Other projects relevant to the topic is the German Technical Cooperation Agency (GTZ) funded programme "Disaster Preparedness in South Caucasus" that focused on Lori and Tavush marzes in which NAS IGS was one of the implementer and "Model Guidelines For Water Basin Management Planning In Armenia" for the Meghriget River funded by United States Agency for International Development (USAID) (in collaboration with the Water Resources Management Agency (WRMA) under the Ministry of Nature Protection).

Currently, are developing the 6 water basin management plans. The Government of the Republic of Armenia, in February 2011, approved the content of the Water Basin Management Model Plan, which has been developed within the framework of the EU Water initiative – according to the requirements of the EU Water framework directive and Water Code. At present, the content of the model plan is a legal document and it is a technical assignment for the development of Armenia's Water Basin Management Plans.

The 3rd and 4th chapters of the Water Basin Management Model Plan contain to the emergency and prevention measures; the measures must be implemented within 6 years after the final approval of the plans by the government.

Currently, in Armenia there are several activities related to the development of a Water Basin Management Plan:

- Arpa river developed during UNDP - Global Environment Facility Reducing Trans-boundary Degradation in the Kura-Araks River Basin Project[27]
- Akhuryan river under the EU funded project "Environmental Protection of International River Basins"(EPIRB[28]). The plan will be submitted to the Ministry of Nature Protection in 2016.
- Model guidelines for water basin management planning in Armenia - Meghriget river implementation, funded by USAID.

According to the requirements of the Government protocol decree N4 dated 03.02.2011, the South Water Basin Management Plan developed within the framework of the USAID Clean Energy and Water Program and the "Ararat valley water basin management plan" developed by the "Armhydroenergo project" CJSC (the state budget funding) have been submitted to the Ministry of Nature Protection, which in 2016 will be submitted to the Republic of Armenia Government for approval. The Water Resource Management Agency under the MNP is the national focal reference for them. Even if these initiatives are much more oriented to the Water Framework Directive than EUFD, it seems to us to be relevant to cite them as Water Basin Management Plans should include emergency plans (water management during emergencies) and disaster recovery plans. Moreover, regardless of the fact that, generally speaking, the flood risk is not assessed, a register of historical floods is set up very often and a census of natural and artificial water bodies are reported as well. For instance, a full characterization of the Meghriget River Basin was completed in the USAID project and published as Synthesis Report of

[27] (UNDP/GEF Kura Araks Project at link http://www.kura-aras.org)
[28] (ENPI-EPIRB project at link http://blacksea-riverbasins.net/en)

Meghriget River Basin Characterization, also including a full description of the climate, hydrology and water quality, biology, geography, socio-economic situation, water use, water balance, major water resource issues of the basin and flood characteristics among them. Within this project, a section is dedicated to the guidelines for the calculation of maximum flow (floods) for both instrumented and non-gauged rivers (see the references provided for PPRD East 1). Along the same lines, information is provided for historical flooding experiences, calculated peak flows and flood flood-prone areas and flood protection infrastructures. Finally, regard to the prescriptions of EUFD, it is significant to highlight as one of the outcomes of the project is a wide production of maps (with a varying scaling from 1:175,000 to 1:200,000) of several geological and hydro-geological layers such as: drainage areas of the sub-basins, average height, soil composition, annual precipitation, etc.

AZERBAIJAN

The current state of flood hazard and risk mapping is at early stage and no substantial activities are present in the Country. There is a need to elaborate flood hazard and Risk maps for all the Areas with Potential Significant Flood Risk identified by PFRA.

During PPRD East 1 a nation-wide flood hazard and risk mapping at NUTS2 level has been developed by applying the methodology developed by PPRD East 1 and based on 4 levels of risk (compliant with EU Guidelines on Risk Assessment). The results are available to registered end users on the ERRA platform.

BELARUS

FHRM is mostly taken care of by means of pilot projects, like the ones on Western Bug, Pripyat tributaries (Styr, Prostyr, Yeselda) and Iput and these projects represent a sound basis for the full implementation of EUFD.
FLOOD-WISE Project (2010-2012) was developed by the District Office of Wlodawa between the District Office of Włodawa (Poland), Central Research Institute for Complex Use of Water Resources (CRICUWR) (Belarus), National University of Water Management and Nature Resources Use (Ukraine) and funded by the Interregional Cooperation Programme INTERREG IVC, and the EU Regional Development Fund. For the Western Bug trans boundary areas a flood risk assessment study has been carried out. High flow probabilities scenarios (1%, 5%, and 10% on a yearly basis) were investigated by means of statistical hydrological methods based on observed data (provided by the HMS of the Republic of Belarus) and a 1-D hydrodynamic model developed by CRICUWR. FHMs and FRMs with a 1:50,000 resolution reporting water depths scenarios for the selected return periods have been drafted for all Western Bug basin. Finally a fully compliant with EUFD prescriptions draft of a FRMP was delivered as the last deliverable of the Project.

UNDP project “Flood Risk Assessment and Monitoring in the Pripyat Basin” (2013-2015) focused on promoting environmental sustainability through regional cooperation. Among other achievements of the project are Flood Hazard and Flood Risk maps for the Yeselda river at a scale of 1:25,000 for different probability scenarios (0.5% - 1% - 10% - 25% on a yearly basis).

GEORGIA

FHRM are available at national scale but they need to be produced in more detailed resolution so that they can be properly used for the development of mitigation measures. Specifically, the ones produced

by the MATRA project are not in full compliance with the EUFD as they are limited to be flood delineation maps and do not report the maximum water depth values associated to the different return periods. However, the new pilot study on the Rioni River seems to be in full compliance with the EUFD Indications.

A nation-wide flood risk mapping has been developed during PPRD East Programme Phase 1 by EMA using the information layer provided by NEA through the MATRA project, taking advantage, as pointed out, of the already developed nationwide hazard and risk mapping. The countrywide flood risk classification developed during PPRD East Phase 1 is a 4-level zonation of Georgia at district-scale.

The hazard maps, that are more frequently flood extension maps related to specific return periods are sent to EMA for validation risk evaluations. EMA on the basis of such maps performs local validation with surveys and local population inquiry. On the basis of such local inquiry the concerns about the Hazard maps are annotated and sent back to NEA for update. The final map is then sent to EMA that performs risk considerations based on the layering of Exposed elements onto the hazard map and details countermeasures to be put in the emergency response plan and mitigation measures to reduce risk. Such mitigation measures are filed in a Letter of Recommendation to the local administration that can in turn evaluate if they can act on local budget or in case request national budget through EMA or MENRP.

MOLDOVA

The situation of Flood Hazard and Risk Mapping is similar to PFRA. FHMs and FRMs have been prepared by Beta Studio and HR Wallingford for the main rivers of Moldova under the Programme “Management and Technical Assistance Support to Moldova Flood Protection”. FHMs and FRMs have been developed with state-of-the-art modelling suites, however there is a need to develop and adopt a methodology that will ensure a homogeneous elaboration of FHMs and FRMs in the whole country.

MoE, with the financial support of the European Investment Bank, is implementing the Programme “Management and Technical Assistance Support to Moldova Flood Protection”. The Programme has the objective to develop a master and investment plan for flood protection. As part of the Programme, the technical assistance has been tendered with the aim of:

1. preparing Preliminary Flood Risk Assessment for Moldova,
2. elaborating hazard and risk maps for the main rivers,
3. identifying flood risk management measures,
4. preparing a GIS-based river basin information platform,
5. providing capacity building for MoE and subordinated structures on hydraulic and risk modelling.

Beta Studio and HR Wallingford implement the Programme, it is in the closure phase and hazard and risk maps for main rivers have been developed.

During PPRD East Phase 1, a nation-wide flood hazard and risk mapping at NUTS2 level has been developed

by applying the methodology developed by PPRD East and based on a 4-level risk assessment (compliant with EU Guidelines). The results are available to registered end users on the ERRA platform.

UKRAINE

The FHM and FRM based on EU standards have been carried out only for the most important basins without a general coordination and homogeneous approach. At a national level, hazard maps are not accessible to public. The coverage is fragmented often with potential substantial methodological differences.

Ukrainian Hydro-Meteorological Center (UHMI) developed maps (1996) for inundation going beyond the maximum consumption with a probability of 1, 5, 10 and 25% for the Desna river from the national border to the river's mouth and for the Dniester river on the following area: Strilky village – Halych city – Zalishchyky city. The maps were computed using 1:25000 topographic maps and are available only on paper. They are not convenient for operational situation assessment and administrative decision-making. Paper topographic maps are accompanied by the list of population centres along the area (river), their distance from the river's mouth and computed consumption of water having a probability of 1, 5, 10 and 25% in their region.

GIS ANALYST mapping tool, developed by UHMI for the SES, provides flood-prone areas for the main rivers of Transcarpathia (Tisa, Borzhava, Oh, Latorica).

The countrywide flood risk classification developed during PPRD East Phase 1 is a 4-level zonation of Ukraine at district-scale and it is available for registered end users on the ERRA platform.

During FLOODWISE project (2010-2012) high flow probabilities scenarios (1%, 5%, and 10%, on a yearly basis) were investigated by means of statistical hydrological methods based on observed data. The hydrological observations on Bug River and some tributaries (for Ukraine's territory) were provided by Volyn Hydro-Meteorological Centre (Lutsk) and Western Bug Basin Water Department (Lutsk). FHMs and FRMs with a 1:50000 resolution reporting water depths scenarios for the selected return periods have been drafted for the entire Western Bug basin.

The Integrated Tisza River Basin Management Plan was delivered by State Committee of Water Management of Ukraine (Trans-Carpathia Water Management Board) comprising a topographic and geodesic survey, the hydrological assessment and the hydraulic calculations and inundation zones for the aforementioned probability.

In the framework of EnviroGrids FP7 project (April 2009 to March 2013) the flood extent (in space and time) and associated flood depth have been determined for Danube Delta using a twofold approach. The maps were designed for a real event in the past, as well as for different synthetic storms with different statistically determined return periods. A portfolio of synthetic simulated events was simulated with the hydrodynamic model ending up in a cloud of stage and discharge values for 125 different cross sections. At each location an extreme value function was fitted for stages to compute FRMs for different return periods (5, 10, 20 and 50 years, respectively).

6.4 Guidance and Methodologies for Flood Hazard and Risk Assessment

The PPRD East1 study includes in **the Risk Assessment Process** three components: Risk identification, Risk analysis and Risk evaluation.

Risk Identification - identifying sources of risk, areas of impact, events and their causes and their potential consequences.

Risk Analysis - developing an understanding of the risk through specific hazard, vulnerability and asset assessments.

Risk Evaluation - evaluation of the risk analysis process is undertaken to assess which risks warrant greater consideration, this allows for a priority list for treatment strategy implementation to be developed.

Accordingly to PPRD East1 Risk/Hazard Assessment Policy29, an Asset characterization process should be conducted in two stages, in order to make the process efficient. In populated and significantly industrialized regions this task may became complex. Two stages are :

- The top screening stage where the importance of the asset is assessed;
- The secondary stage where assets are selected examined in more detail and used in analysis.

Stage 1 - Top screening

Gathering basic data for all assets including size, location, structure, age, purpose of the facility / asset, initial estimation of importance / consequence if it were to be diminished / fail. Additional data matched to the hazard risk assessment, assuming the worst case – for example types of material stored (toxicity), maximum fatalities, and serious injuries, financial and economic losses. Great precision is not required at this stage as it is merely used to exclude low consequence items from further assessment, but retain their record in the event that changes are recognized or the asset is required as part of a disaster recovery plan.

Stage 2 - Asset Selection

The next stage is important in taking the remaining assets forward to a full characterization process so that they can be used in subsequent threat, vulnerability and consequence analyses. To do this the steps in Table 10 below should be followed and data coming out of each step recorded. It should be noted that there will be a significant degree of re-iteration between steps 1 to 3, and that step 3 is in particular dependent on the scale/ level being adopted (e.g. specific organization /operation, local or regional) of the assessment. These 3 structured stages enable the characterization of the various physical, logical and resource factors that may be required in subsequent analyses. Step 5) can be defining step since if the consequence isn't high the view may be taken that further analysis isn't warranted.

Step	Task	Details
1	Identify critical functions	Identify critical functions of the asset at the appropriate level (local / regional)
2	Identify critical assets	Identify critical assets / components of that enable 1) above
3	Identify critical infrastructures	Identify critical internal and external infrastructures (scale dependent) and any dependencies
4	Identify existing countermeasures	Identify what protects the functions and assets in 1) -2) against the hazards / threats envisioned (e.g. building codes, contingency plans, redundancy)
5	Identify potential consequences	Identify the potential (worst) consequences / impacts to the assets and functions from disruption and total loss
6	Select assets for next stages in analysis	From 4) and 5) develop a ranked list of critical functions and assets which will be used in further risk and resilience analysis

[29] (PPRD East1 Risk/Hazard Assessment Policy for the ENPI Eastern Region (2012) at link http://euroeastcp.eu/assets/files/Publications/Risk%20Hazard%20Assessment%20Policy_en.pdf)

Table 10. Asset Characterization Steps

Once captured this data from the selected assets can be taken forward to the vulnerability and consequence analysis stages of the hazard risk assessment.

Hazard risk assessments are typically undertaken by specific hazard focused institutions, Government ministries and other entities. The maps are developed through the interpretation of historical data/ reports, current recording techniques and expert opinion.
When considering the scope of this project the development of hazard maps are particularly relevant when determining the risk associated with the possible occurrence of seismic events, flooding, drought, forest fires and chemical accidents. Assessment and presentation methods covering all types of hazards adopted by the different Partner Countries need to be consistent regarding their data output.

Vulnerability assessment

Vulnerability assessments are also an essential element of local community preparedness. By understanding local vulnerabilities measures can be implemented to reduce their exposure to the possible onset of a disaster. Community participation is known to assist their own development by empowering affected individuals to improve their own capacity to anticipate, cope, resist and recover to the onset of disasters.

7. Flood Risk Management Plans

In 7.1 is given an overview of EUFD main requirements on Flood Risk Management Plan. In 7.2 a summary on status of development of Flood Risk Management Plans in Partner Countries is provided. The information collected during NAG meetings in 2015 and reported in Country Profiles of Partner Countries is included. In 7.3 divided into two subsections 7.3.1 WMO approach on Flood Risk Management Plan and 7.3.2 PPRD East1 study on Risk/Hazard Assessment are provided. In final paragraph 7.4 a resumptive of Guidance on Flood Management Plan development composed of Floods Directive, WMO and PPRD East1 recommendations and components for formation of flood risk management systems.

7.1 The Scope of Flood Risk Management Plans by EUFD

As defined by Floods Directive European Member States should provide FRMPs by the end of 2015.

States shall establish (Article 7) appropriate objectives for the management of flood risks areas focusing on the reduction of potential adverse consequences and on non-structural initiatives. Flood risk management plans shall take into account relevant aspects such as costs and benefits, flood extent and flood conveyance routes and areas which have the potential to retain flood water. Flood risk management plans will focus on prevention, protection, preparedness, including flood forecasts and early warning systems and taking into account the characteristics of the particular river basin or sub-basin.

Flood risk management plans may also include the promotion of sustainable land use practices, improvement of water retention as well as the controlled flooding of certain areas in the case of a flood event. In the interests of solidarity, flood risk management plans established in one country shall not include measures which, by their extent and impact, significantly increase flood risks upstream or downstream of other countries in the same river basin or sub-basin.

Main Steps for flood management plan development

Step 1. In the River Basin Management Plan there is a catalogue of measures. Quantify the consequences that these measures will have on floods.

Step 2. In case there are measures that will have an negative effect on floods, reconsider them. Study the measures in an integrated way to see whether this problem can be solved (see as well Step 3).

Step 3. Creations of synergy between measures proposed by the two directives: Water Framework Directive and Floods Directive.

Step 4. Inclusion the public consultation in the process.

Step 5. Organization of the process of finalization of RBMPs and FRMPs in such a way that public participation, official approval and reporting towards the EU runs parallel as much as possible.

Coordination between Flood Risk Management Plans and River Basin Management Plans

According to the Floods Directive, development of River Basin Management Plans under Water Framework Directive 2000/60/EC and of Flood Risk Management Plans under this Floods Directive 2007/60/EC are elements of Integrated River Basin Management. The objectives of the two Directives should be in line.

List of types of measures for Flood Risk Management

In terms of the Risk Management cycle, the document "Guidance for Reporting under the Floods Directive (2007/60/EC)"[30], provides information on the steps to be performed (Table 11)

Aspects of flood risk management	Description
No Action	No measure is proposed to reduce the flood risk in the APSFR
Prevention	Preventing damage caused by floods: (1) by avoiding construction of houses and industries in present and future flood-prone areas; (2) by adapting existing receptors to the risk of flooding and ensure that future developments take flood risk into account; (3) by promoting appropriate land-use.
Protection	Taking measures, both structural and non-structural, to reduce the likelihood of floods in a specific location
Preparedness	Informing the population about flood risks and what to do in the event of a flood; including emergency response: developing emergency response plans in the case of a flood.
Review/Lessons learnt	Returning to normal conditions as soon as possible and mitigating both the social and economic impacts on the affected population.
Other	Other type of measure

Table 11. Stages of Flood Risk Management Cycle

7.2 Overview of Current Status of Flood Risk Management Plan in Partner Countries

The information on current status of Flood Risk Management is based on NAG meetings survey and Country profiles reports of 2015. In Table 11 are summarised general state on current status of PPRD East2 partner countries on FRMP implementation.

EaP Countries	FRMP operating in the country
Azerbaijan	Not developed
Armenia	Are developed for major rivers
Belarus	In development for major rivers
Georgia	Not developed
Moldova	Not developed
Ukraine	Not developed

Table 12. FRMP development status in the partner countries

ARMENIA

Water basin management plans are in their final stretch for at least 4 major Armenia's catchments, nonetheless they are much more focused on water quality and water supply. For this reason, it is recommended to include flood risk management principles in line with EUFD.

[30] (Guidance for Reporting under EUFD at link: https://circabc.europa.eu/sd/a/acbcd98a-9540-480e-a876-420b7de64eba/Floods%20Reporting%20guidance%20-%20final_with%20revised%20paragraph%204.2.3.pdf)

It is noteworthy to recall that EUFD-compliant FRMPs also consist of an effective EWS. Armenia has already in place a system for weather and flood forecasting (managed by the State Armenian Hydro-meteorological Service) and response (MTAES).

Nonetheless, for a further development of the whole system, it is recommended to improve the efficiency of the observational network, increasing the number of automated stations (rain gauges, thermometers, hydrometers etc.).

AZERBAIJAN

Currently there are no FRMPs operating in the country and neither a plan to develop them. There is a need to develop FRMP and identify structural and non-structural measures for flood risk reduction and mitigation according to the indication of the EUFD. The FRMP should be the planning documents for the identification and prioritization of the flood defence infrastructure designed and realized by the Committee of Land Reclamation and Water Resources (LRWM OJSC). Furthermore, FRMP has to include the establishment of the National Early Warning System of Azerbaijan.

It is recommended to develop FRMPs for all the Unit of Management of the country, starting from a pilot basin. The FRMP needs to be integrated with the River Basin Management Plan as required by the EU Water Framework directive and EU Floods Directive. It is further recommended to establish a mechanism for the effective implementation of the FRMP including the National Early Warning System and to strength the observational network.

BELARUS

Currently there are no operational RBMPs in the country, a draft is available only for Upper Dnieper and the development of RBMPs for 5 main rivers (Upper Dnieper, Pripyat, Western Bug, Nieman and Western Dvina) is under way. Nonetheless, the focus of these plans is on water quality and floods are addressed marginally.
For this reason, it is recommended to include flood risk management principles in line with EUFD.

Belarus has already in place an effective system for weather and flood forecasting (managed by the State Hydro-meteorological Service under the MoNREP) and response (MoES).
Nonetheless, for a further development of the whole system, it is recommended to improve the efficiency of the observational network, increasing the number of automated stations (rain gauges, thermometers, hydrometers etc.).
In response to this recommendation the MoNREP highlighted that according to the Resolution of the Council of Ministers of the Republic of Belarus of 20 June 2013 #503 "On Certain Issues of the MONREP of the Republic of Belarus", the competence of the Ministry does not include the issues of flood hazard and risk prevention, including those related to development of flood risk management plans. Moreover, under national legislation including the one considering the administrative and territorial local self-governance system (oblast, rayon), it is opinion of the MoNREP that the actions (as part of road maps) proposed by international experts with respect to the Government, the MoNREP and Basin Councils are premature.

GEORGIA

Currently there are no FRMPs operating in the country. The NEA and EMA are both aware about the need to develop the plan and, at the practical level, parts of the FRMPs already are implemented in the

form of recommendations to local authorities. This needs to be taken up at the legislation level and clear responsibility for development, implementation and update of the plans needs to be established.
It is recommended to update of the current legislation on river basin management plans. Application of the EUFD prescriptions to RBMPs. Purchase, installation and calibration of automated stations filling the gaps left by pilot projects already in place.

MOLDOVA

Currently there are no FRMPs operating in the country and there is a need to identify structural and non-structural measures for flood risk reduction and mitigation according to the indication of the EUFD. FRMPs need to be integrated with RBMPs and, specifically, with the ones already developed for Dniester and Prut rivers and some sub-basins. FRMPs need also to include an early warning system and to integrate local, territorial and state disaster and civil protection plans.
It is recommended to develop FRMPs for all the Units of Management of the country and to integrate them with the RBMPs as required by both WFD and EUFD. It is further recommended to establish a control mechanism to periodically check-up the effective development and implementation of the FRMPs.

UKRAINE

River basin management plans have not been formulated conclusively. Measures are much more focused on water quality and water supply for different use. It is noteworthy to recall that EUFD-compliant flood risk management plans also consist of an effective Early Warning System. Ukraine has already in place an effective system for weather and flood forecasting (managed by the UHMC) and response (SES).
For a further development of the whole system it is recommended to include flood risk management principles in line with EUFD into the river basin management plans and to improve the efficiency of the observational network by modernizing, reequipping technically and technologically, increasing the number of and further developing automated stations engaged in measuring water levels, rainfall etc.

In Table 12 recommendations on FRMP to partner countries developed after NAG meetings 2015 are provided.

EaP Countries	*update of the current legislation on RBMPs*	*include flood risk management principles in line with EUFD*	*develop FRMPs for all the Units of Management*	*improve the efficiency of the observational network*
Azerbaijan		V	V	V
Armenia				V
Belarus		V		V
Georgia	V	V		V
Moldova			V	
Ukraine		V		V

Table 13. Recommendations to EaP countries on FRMP development (NAG meetings 2015)

The Flood Risk Management plans in partner countries generally demonstrate lack of readiness. Usually the flood risk management principles are developed only at local level/partially and need to be brought

in line with EUFD. The observational network frequently is insufficient. The definite legislation and clear responsibility for development, implementation and update of the plans should be designed. Among the main recommendations on Flood Risk Management process development, provided in Country profiles to partner countries, are:

- *update of the current legislation on RBMPs*
- *include flood risk management principles in line with EUFD*
- *develop FRMPs for all the Units of Management*
- *improve the efficiency of the observational network*

Armenia, Georgia, Moldova and Ukraine are selected support for the Approximation to EU Floods Directive among priority activities.

7.3 Review of International Guidance on Flood Risk Management Planning

In this section are provided WMO Guide for Integrated Flood Management recommendations and PPRD East1 integrated study on Risk/Hazard Assessment. The WMO Guide emphasize the important role of floods in maintaining the natural function of river and flood plains and also as sources of fresh water and other natural resources. The PPRD East1 policy includes on the hazard risk management framework in the culture and practise of the Government systems.

7.3.1 WMO Guide for Integrated Flood Management

The WMO Guide for Integrated Flood Management[31] provides the contents and basic procedures of basin flood management planning. This Guide represents an additional source of information on FRMP development. Several fundamental issues related to the flood management planning, such as national development of vision/policy and enabling mechanism of flood management planning, are explained. The flood management policy should be closely aligned to the water resources development and management and designed separately from disaster management policies.

The “Integrated Flood Management” (IFM) means harmonization of human behavior in relation with river regime. In this relation the evaluation of beneficial function of floods and negative consequences of flood risks is the first step in developing of a Flood Management Plan.

According to WMO recommendations the Basin Flood Management planning should reflect the overall vision and policy of Integrated Water Resources Management (IWRM) with particular attention on the management of floods. IWRM approach has been accepted internationally as the way forward for efficient, equitable and sustainable development and management of the world's limited water resources and for coping with conflicting demands. The basic cycle for developing an IWRM plan as given in Figure 5.

[31] (Formulating a basin flood management plan, WMO, 2007; http://www.apfm.info/publications/tools/Tool_01_Basin_Flood_Management_Plan.pdf)

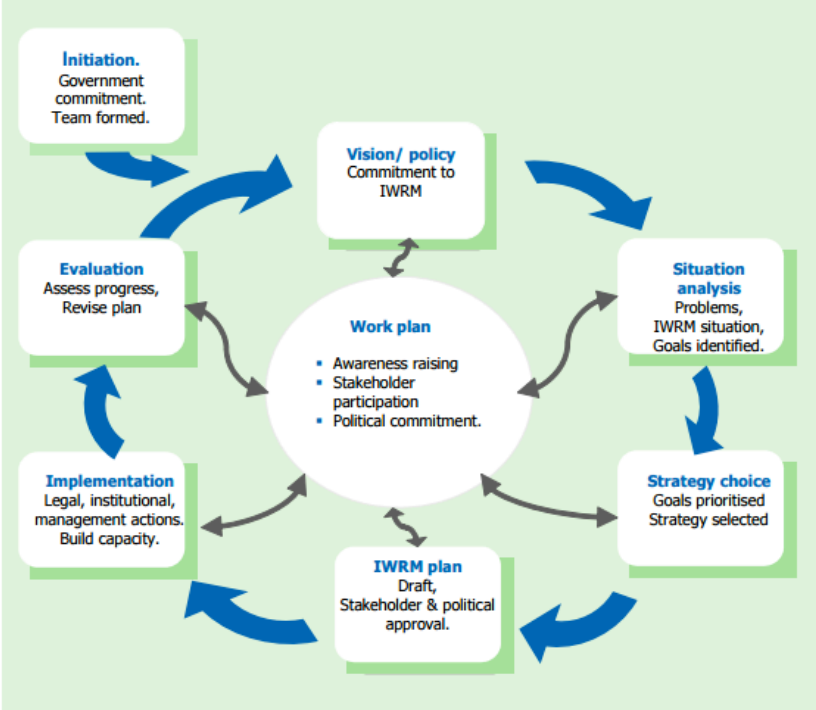


Figure 9. The Cycle for Developing and Adjusting an IWRM Plan[32]

Basin Flood Management is recommended to be led by the assigned authority or group of authorities that have responsibilities of flood management and basin planning. The Integrated Flood Management (IFM) is an integral component of Integrated Water Resources Management and should be formulated in close coordination.

Common themes for the **Flood Risk Management Plan** and the **River Basin Management Plan** are:

- Maintenance of natural dynamic water courses (protection/restoration of floodplain areas, restoration of meander of rivers, solid transportation, etc.) and the wetlands, including improvement of knowledge.
- River maintenance, avoiding the possible contradictions between the objective to reach good ecological status of surface water bodies and measures to reduce flood risks, for instance ecological restoration, vegetation maintenance or logs suppression to make the flow easier.
- Runoff and erosion control.

Specific themes for the **Flood Risk Management Plan** are:

- Land management in order to reduce vulnerability of goods;
- Structural measures like dams or dikes;
- Public awareness, public information, consciousness of the flood risk;
- Preparedness and crisis management;
- Flood forecast, early warning;

[32] (Integrated Water Resources Management Plans, Training Manual and Operational Guide (2005) CapNet, GWP and UNDP at link http://www.gwp.org/Global/ToolBox/References/IWRM%20Plans%20Training%20Manual%20(Cap-Net,GWP,UNDP,%202005)%20ENGLISH.pdf)

- Diagnosis and knowledge of stakes and vulnerabilities;
- Hazard knowledge.

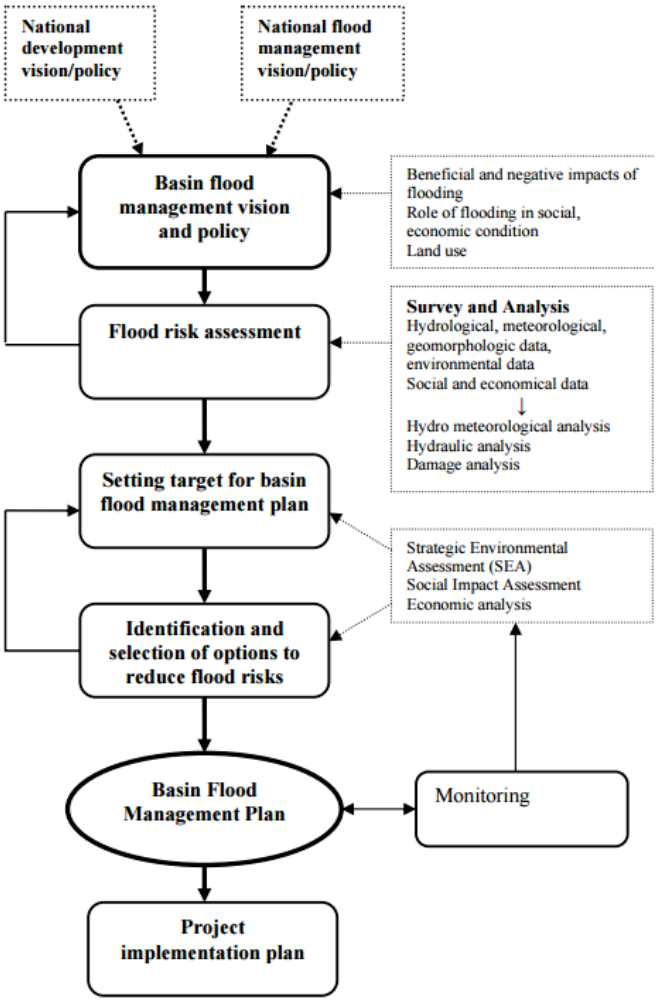


Figure 10. Steps on Basin Flood Management Planning[33]

Figure 6 provides main steps of Basin Flood Management Planning. The building of capacity of different stakeholders may require an enabling legal and institutional framework. In an international river basin the stakeholders, divided under different national government structures, involvement becomes more complex.

Data Survey and Analysis

The different categories of data and analysis are required to understand the flood issues, evaluate the current socio-economic conditions and the impacts of floods, project the future scenarios of development and climate change and the ecological consequences for the formulation of the basin flood management plan.

Basin condition: Meteorological data; Hydrological data; Geomorphologic data; Environmental data.

Social and economic condition:

- Land use practices in the basin including flood plains

[33]WMO Formulating a Basin Flood Management Plan – A Tool for Integrated Flood Management, 2007

- Pattern of human settlements in and around flood plains
- Demographic profile of flood plain inhabitant
- Location of natural resources
- Livelihood sources in and around the flood plains
- Infrastructure and other assets in the flood plains
- Future development plan in the basin
- Social and economic damages in the past flood

An expert group may serve as the basis for continuous monitoring of data before, during and after implementation of the plan.

Impacts of floods

In a river basin, development activities on the flood risks can impact the flow regime (ex. changes in timing and volume, and quality of flood waters) and/or increase exposure of economic activities. The overall review of various development policies on the flood risks is an essential first step. In Table 13 is given a partial list of possible impacts. More detailed explanations on range of environmental issues involved in flood management are provided in WMO "Environmental Aspects of Integrated Flood Management"[34] (2006). This publication provides recommendations on flood risks management in relation to environmental concerns and sustainable development, and looks how environmental considerations can be appropriately incorporated in flood management practices.

National development policy	Likely changes in	
	Flow regime	Exposure to flooding
Agriculture		
Fishery		
Forest management		
Industry		
Urban development		
Environmental management		
Social condition improvement		
Others		

Table 14. Flood risks impact

7.3.2 PPRD East 1 Regional Risk Management Policy

The PPRD East1 study on Risk/Hazard Assessment[35] defined common themes and components of Regional Risk Management Policy, considering EU best practise while also tailored accordingly to the realities and constraints within the partner countries. It considered as an integral part of the Hazard Risk Management Framework and should be embedded in the culture and practise of the Government systems.

Themes	Components	Description
Communication	Government sectors	Mandates and Polices to assist the development of a cross cutting DRR platform

[34] (WMO, Environmental Aspects of Integrated Flood Management, APFM Technical Document No.3, 2006) at link: http://www.apfm.info/publications/policy/ifm_env_aspects/Environmental_Aspects_of_IFM_En.pdf)

	Stakeholders	Hazard focused institutions, financial institutions, overseeing organisations, DRR practitioners, representatives from affected communities
	Media	Dissemination and communication of warning information through radio, television, newspapers and social media to public. Preparedness and educational information prepared by scientists, Government officials and DRR practitioners.
Treatment and Mitigation Measures	Electronic Regional Risk Atlas (ERRA)	National level: Visualisation of possible hazards and its impact. Regional and Local level: general information on key infrastructures; population vulnerability; level of risk, associated with a certain location. Support information for decision making regarding treatment strategies.
	Early Warnings Systems	Forecasting and Monitoring systems (meteorological stations, river level sensors, etc.) based on trigger levels. Details on development of Early Warning Systems are provided by EC – Strengthening Early Warning Systems in Europe, 2007[36]
Community preparedness	Community involvement and improvement of their resilience by different activities	Awareness, training and educational programmes. Maintaining appropriate early warning systems, gaining political support, agency mandates, acquiring resources, developing personal skills, expertise and knowledge, managing information, and managing linkages with networks of relevant stakeholders.
Technology	Data capture methods	The setting up and dissemination of appropriate forecasting and early warning information in the occurrence of hazardous events.
Traditional Wisdom	Coping mechanism or coping strategy	The choice of skills and resources to be applied varies according to the nature of the threat, the capacities available to deal with it, and a variety of community and individual priorities.
Preparedness through the EU Civil Protection Mechanism	Five approaches to prepare member states for the natural and man-made disasters	– Training and Exchange of Experts – National Expert Tabloids – Exercises – Early Warnings Systems and Other Technologies – Developing Technologies to Fight Disasters
Prevention	Preventative measures incorporated into national planning	– DRR and the National Development Planning Process – Poverty Reduction Strategies – Country Planning – Environmental Sustainability – Infrastructure - designing new infrastructure and the strengthening existing infrastructure
Disaster Response Framework	Tools aligned with EC Policies	Monitoring and Information Centre (MIC) Common Emergency and Information System (CECIS) Civil Protection Modules assistance
Regional Consistent	Bilateral	To assist mitigation and prevention across the region

[36] (European Commission - Strengthening Early Warning Systems in Europe, 2007 at link: http://ec.europa.eu/echo/policies/prevention%20preparedness/preparedness%20en.htm)

Approach	Agreements	
Roles and Responsibilities	Assignment of responsibilities in relation to the risk management framework components	Government Overseeing Ministries Other Ministries Hydro-Meteorological system Local Authorities Communities International Non-Governmental Organizations Non-Government Organizations

Table 15. Themes and components of PPRD East1 Regional Risk Management Policy

7.4Guidance for the Preparation of Flood Risk Management Plans

This section presents recommendations on Flood Risk Management Plan development of IPA Flood Guidelines[37], WMO approaches[38] and PPRD East1 study[39]. These can be use as Guidelines for FRMPs in the EMPI East Region.

The process of development of a Flood Management Plan requires three main key components:

- Political commitment;
- Public awareness;
- Suitable delivery team: steering committee, task team, coordinating body.

Stakeholders identification

In the absence of a river basin organisation, as a first step, it is essential to set up a core team consisting of representatives from key institutions that are mandated with flood management, water resources management, agriculture, disaster management and environment.

The basin flood management plan requires identification of all relevant stakeholders. Apart from the general stakeholders a Flood Risk Management Plan requires the disaster management institutions to actively participate in the process.

The core team should set up a flood management committee or a steering group consisting of different key stakeholder ministries including financial ministry.

Stakeholder participation

Stakeholder participation will start from the formulation of Flood Risk Management vision and policy, the process of which will initiate the public motivation to be involved, and create the common base for the discussion among various stakeholders. The public hearing or open forum as effective tool to the process are often applied in view of because of the large number of interested parts.

Decision making process should be agreed and formalized in the beginning of the process. The process should state that who should make decision and how, to avoid conflicts of interests.

Understanding of risks helps create the national consensus on fund allocation to flood management.

[37] Guidelines for the implementation of EU Floods Directive and EU Member States Good Practices, First Release, IPA Floods, 2016

[38] (Formulating a basin flood management plan, WMO, 2007; http://www.apfm.info/publications/tools/Tool_01_Basin_Flood_Management_Plan.pdf)

[39] (PPRD East1 Risk/Hazard Assessment Policy for the ENPI Eastern Region (2012) at link http://euroeastcp.eu/assets/files/Publications/Risk%20Hazard%20Assessment%20Policy_en.pdf)

Setting target for basin flood management plan

The overall objective of a Flood Risk Management is to prevent flood hazards turning into disasters while maintaining the benefit of floods.

Systematic actions in the cycle of preparedness, response and recovery based on the flood risk assessment carried out would help determine the distinct targets. These targets should clearly express as to how the flood risks would be reduced or managed. Depend on the natural conditions, state of socio economic activities and resultant damages the targets can vary within a basin.

For example, the target for rural areas in a hypothetical basin could be:

- To reduce flood risks in rural agricultural areas by avoiding exposure to floods below 10 years frequency;
- To deal with risks from all higher floods by reducing the exposure and vulnerability.

Identification and selection of options to reduce risks (WMO, 2007)

Flood risks are composed of three components: flood hazards; exposure of economic activities and the vulnerability of the society affected by floods. The issue is to reduce each of the components. Based on the target of flood management that issue should be resolved.

Below is given a list of possible options for reducing each constituent of flood risks.

Reduce Hazard	Reduce Exposure	Reduce Vulnerability
- Retaining water where it falls (increasing infiltration, rooftop storing) - Retention basins (natural wet lands or depressions, man-made e.g., school play grounds, household underground tanks - Dams and reservoirs - Diversion channel - Land use management (e.g., house building codes in urban areas, infrastructure building practices, appropriate landscape planning)	- Structural measures on the river (Dykes, river training work such as channelization, flood walls, raised infrastructures such as roads and railways) - Structural and nonstructural measures/actions by individual (flood proofing) - Land regulation - Flood emergency measures (flood warning and evacuation)	- Physical: by improving the infrastructure, well-being, occupational opportunities and living environment - Constitutional: by facilitating equal participation opportunities, education and awareness, providing adequate skills and social support system - Motivational: by building awareness and facilitating self organisation

The listed options should then be checked by a multistage screening process from various perspectives: technical feasibility, economic efficiency, social acceptability and environmental viability. Technical standards or criterion should be adopted or developed to assess technical feasibility. This guarantees the consistency of designing and maintains the level of safety of structure. Such an analysis would best be carried out through an inter-disciplinary team of experts not only from the major stakeholder ministries and institutions but also specialise non-governmental organisations closely associated with flood issues.

Implementation Plan and Monitoring (WMO,2007)

There are several requirements for the implementation of basin flood management plan, such as:

- Legal and institutional arrangements, to ensure the participatory process;
- Clear assignment of the roles and responsibilities: assignment of tasks among organizations responsible;
- Draw timelines for meeting short- medium- and long-term target;
- Assess the financial resources and the way these resources are to be mobilized;
- Consultation with financial institutions to secure financial resource;
- Draw out alternative approaches to meet the targets;
- Identification of possible external resources;

The essential concern is monitoring of river basin condition before, during and after the implementation of the plan. The indicators and threshold values for various level of management should be assigned. If adverse affects beyond the specified threshold values are observed, modification and adjustment in the plan should be carried out.

Flood Risk Management Plans[40] must include:

- a map showing the boundaries of the Flood Risk Area
- the conclusions drawn from the flood hazard and risk maps
- objectives for the purpose of managing the flood risk
- proposed measures for achieving those objectives
- a description of the proposed timing and manner of implementing the measures including details of who is responsible for implementation
- a description of the way implementation of the measures will be monitored
- a report of the consultation, where appropriate, information about how the implementation of measures under the Flood Risk Management Plan and River Basin Management Plan area will be coordinated.

[40] (UK Guidance on Flood Risk Management Plans (2014) at link https://www.gov.uk/guidance/flood-risk-management-plans-what-they-are-and-whos-responsible-for-them)

8. Conclusions

The guidelines are developed on the base of EU Floods Directive 2007/60/EC, Good Practices of EU Member States on PFRAs and FHRM development, the European Overview Report on PFRAs, the European Overview Report on FHRMs, PPRD East1 Risk/Hazard Assessment Policy and WMO Tool for Integrated Flood Management.

EU Floods Directive 2007/60/EC

This document provides an introduction to EU Floods Directive 2007/60/EC and general explanation on development of flood risk management approach to reduce the probability of flooding and its potential consequences. The three main steps are defined:

- Preliminary Flood Risk Assessment;
- Flood Hazard and Risk Mapping;
- Flood Risk Management Plan;

The EUFD implementation process is recommended to start from a complete definition of stakeholders and skills. Afterwards the implementation of the *PFRA Phase 1* operational procedures on preliminary assessment of areas with potential significant flood risk is begun. The basic data collection recommended by EUFD should include:

- historic information on past flood events;
- Social, Economic, Environmental, Cultural receptors;
- description of minimum geospatial elements: river network, land use, distribution of population.

PFRA Phase 2 is a preliminary flood risk evaluation through combining the basic data obtained in PFRA Phase 1 to produce:

- Preliminary flood hazards (from: Historical floods / floodable areas + spatial buffer);
- Preliminary flood risk (from: Preliminary flood hazards + Population density maps + Other geospatial data about exposure).

In Phase 2 the method (or the combination of methods) for flood prone areas should be identified.
The flood-prone areas identified in the *PFRA Phase 1* in combination with risk receptors provide a final map with the areas of Preliminary Flood Risk.
The Flood Hazard Risk Assessment and Mapping phase starts with definition of responsible institutions with technical knowledge. Then the common criteria for FHRM are defined by EUFD:

- Type of floods to be considered;
- Type of information needed for the hazard/risk maps;
- Kind of hazard and risk maps produced.

The risk maps should include elements under risk such as: people, economic activities, and industries/installations in the potential inundated areas. Flood Hazard Maps (FHM) scenarios and elements for modeling are defined in sub-section 4.2. Flood Risk Maps are developing on the basis of the FHM for the same scenarios.
Flood risk management plans as defined in EUFD should *focus on prevention, protection, preparedness, including flood forecasts and early warning systems and taking into account the characteristics of the particular river basin or sub-basin.* The stages of Flood Risk Management Cycle are provided in sub-section 5.1.

WMO Flood Risk Management Plan

The WMO approach on Flood Risk Management Plan (in sub-section 5.3) provides further explanations, on basic procedures for basin flood management planning development and serves as an additional WMO established information on Flood Risk Management Plan development. The principal steps of WMO Flood Management Plan design include:

- The planning process: stakeholders, public awareness, steering committee, task team, coordinating body;
- Data Survey and Analysis on Basin condition and Social and economic condition;
- Assignment of indicators and threshold values for various level of management;
- Setting target for basin flood management plan: how the flood risks would be reduced or managed;
- Identification and selection of options to reduce risks: reducing of hazard, exposure and vulnerability;
- Implementation Plan and Monitoring: organisation of participatory process, assignment of the roles and responsibilities, timelines definition, resources assessment, drawing of alternative approaches.

WMO "*Formulating a Basin Flood Management Plan*" recommends associate a Basin Flood Management Planning with an Integrated Water Resources Management plan. The essential concern by WMO is monitoring of basin condition before, during and after the implementation of the plan. The necessary steps should assist in successful implementation of Flood Management Plan at basin level.

PPRD EAST 1 Risk/Hazard Assessment Policy

The PPRD East1 Assessment Policy provides fundamental concepts of Risk Management Process compliant with EUFD, in particular for PFRA. The hazard risk management chain is divided into main components: Establish the context; Identification; Analysis; Evaluation and Treat Risks.

The first is to establish a context and define risk criteria, external and internal parameters, scope and objectives for entire Risk Management Process. After that begun Risk Assessment Process including three aspects: Risk identification, Risk analysis and Risk evaluation. Risk Treatment consists in selection and implementation of the most appropriate risk treatment options. Continuous communication and consultation process ensure precise and proper exchange of information during Risk Management. Monitoring and Review should be maintained during whole process of management to insure efficient operation of management chain.

Current Status of Flood Risk Management in EaP Countries

As NAG meetings (2015) demonstrated, that the Flood Risk Management plans in partner countries generally demonstrate lack of readiness. Usually the flood risk management principles are developed only at local level/partially and need to be brought in line with EUFD. The observational network frequently is insufficient. The definite legislation and clear responsibility for development, implementation and update of the plans should be designed. Among the main recommendations on Flood Risk Management process development, provided in Country profiles to partner countries, are:

- *update of the current legislation on RBMPs*
- *include flood risk management principles in line with EUFD*
- *develop FRMPs for all the Units of Management*
- *improve the efficiency of the observational network*

Armenia, Georgia, Moldova and Ukraine among priority activities during PPRD East2 are selected Support for the Approximation to EU Floods Directive. The further work on development of guidelines on FHRM and FRMP and approximation to EU practice will be continued under consultations with PPRD East2 experts and with direct involvement of all stakeholders.

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10. Annex 1 – Types of Floods

The EU Floods Directive 2007/60/EC covers all kind of floods: river, lakes, flash floods, urban floods, coastal floods, including storm surges and tsunamis on all of the EU territory. According to (Quevauviller, 2014) below are listed flood types that should be included in modelling:

1. **Riverine floods**. Riverine floods are primarily caused by prolonged, heavy precipitation, snowmelt or combinations of both in the catchment area. This leads to high flows and water-stages in the receiving streams and rivers. These floods are often large-scale events in the sense of accumulating rainfall from a large drainage area with flood waves passing through the river corridor for extended periods of time (from several days to several weeks).

2. **Pluvial floods**. Pluvial flooding—or surface water flooding—concerns mainly urban areas and is defined as flooding that results from rainfall-generated overland flow before the run-off enters any watercourse or sewer system. It is usually associated with high intensity rainfall cells within longer duration events or convective thunderstorms. The intensity of rainfall can be such that the run-off totally overwhelms surface water and underground drainage systems. In theory, no area is entirely free from the risk of pluvial flooding although depressions in the topography and surface flow paths may be more susceptible.

3. **Flash floods**. A flash flood is generated by a causative event—intense rainfall—in a short period of time and is characterized by a sudden increase in level and velocity of the water body. The term “flash” reflects a rapid response to the rainfall event, with rising water levels in the drainage network reaching a crest within minutes to a few hours of the onset of the flood event, leaving extremely little time for warning. Thus, flash floods are localized phenomena that occur in catchments with maximum response times of a few hours. At spatial scale and according to the catchment characteristic, the risk corresponds to surfaces below 3000 to 4000 km^2. The two key elements are rainfall intensity and duration. Topography, soil conditions, and ground cover also play an important role. Dam failure and similar phenomena could be described as flash floods.

4. **Coastal flooding**. Coastal flooding, the inundation of land areas along the coast by sea waters. It occurs when intense, offshore low-pressure systems drive sea water inland. Storm winds cause the sea water to pile up on the coast, leading to sudden inundation and flooding of coastal regions. The shallowness of water may considerably modify the surge heights in the region. Due to the immense volumes of water and energy involved, the effects of tsunami can be devastating, as during the event recorded in Japan in 2011.

5. **Flooding due to groundwater rise**. A groundwater flood results from a rise in groundwater level sufficient for the water table to intersect the ground surface and inundate low lying areas. The phenomenon is rather sporadic in time and location, but when it occurs inundation usually lasts longer than flooding inflicted by riverine floods.

6. **Flooding due to lake overflows**. When lake inflow exceeds the outflow the lake levels rise. In contrast to riverine flooding not the peak discharge, but the volume ofinflow in excess to

outflow capacity is decisive. Total rise and rising velocity are determined by the size of the lake surface in relation to the excess inflow.

7. **Flooding due to ice-jam/snow melts**. Snow melt and ice conditions impact many particularly in the Northern Hemisphere. Some rivers occasionally develop partial ice covers while other rivers are completely ice covered for more than six months of the year. The uncertainties associated with climate variability create uncertainties in the duration, extent and severity of future river snow and ice covers and their associated flood potential.