



Historic flood events in Europe: European case studies based on the reporting under the Floods directive



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Executive summary

The purpose of this report is to support the discussion on the practices of reporting for the preliminary flood risk assessment (PFRA). The focus is on the economic and environmental impacts of flooding. This review only includes a subset of the reported past flood events. By consequence the conclusions are preliminary and the cases presented have to be seen as examples only.

The different member states have gone through a similar process of collating and reporting relevant information. The absence of a common set of criteria is a potential reason for differences. Also the availability, and ease of access to, reliable information may have had an effect. It is important that there is a clear link between the information collected and its utility to help reaching more informed decisions.

In order to help achieving an overview of flood impacts at EU level, the main issues to be considered are: revised guidance on the use of the categories of environmental and economic impacts, and revised guidance on the criteria to classify floods as 'significant'.

In order to support the use of the PFRA reporting as a basis for a European Flood Impact Database, the main issues to be considered are: the availability of already existing databases, better understanding of how to quantify economic and environmental impacts, and a better understanding of flooding as a probabilistic phenomenon.

Introduction

The information contained in historical flood information is potentially very important, and best practice should, as much as possible, make use of this data in the assessment of the current and future flood risk. However, the availability of relevant flood (impact) data and the procedures used for transforming this data into information regarding the current and future flood risk vary considerably between Member States as highlighted in a number of recent surveys of European procedures for flood frequency estimation (Castellarin et al. 2012; Madsen et al. 2013) and existing databases on flood impacts (EEA et al. 2013). This report reconfirms that conclusion.

The purpose when writing the report has been, to support the discussion on the practices of reporting for the preliminary flood risk assessment (PFRA), and where feasible to make suggestions and recommendations for future guidance. The report further explores the possibilities to use the PFRA reporting as a basis for a European Flood Impact Database. This report is **not** part of the compliance check for the PFRA under the floods Directive¹. It uses only a subset of the information reported by the

¹ EC, 2007, 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) (OJ L 288 06.11.2007).

Member States to the European Commission using the EIONET Central Data Repository² (CDR) and has to be seen as examples only.

1. Geographical spread of reports

All the Floods Directive reporting of the EU Member States, available on the Central Data Repository website³, could be used for this exercise. However the exercise is based on examples and has no pretention neither to be comprehensive nor complete. The reporting of the following Member States was not taken into account:

- Belgium, Italy and the Netherlands (use of Art. 13§1b and so no past flood events were reported);
- Portugal (no reporting available on 01/05/2013);
- Hungary and Malta (use of a different structure for the reporting that couldn't be included in the framework used).

This report only looks at past floods, not at the potential future ones reported. It looks at case studies for methodologies on the level of the unit of management (UoM) as well as at the information available on a selection of larger flood events across Europe (selected from the “Catalogue of Large Floods in Europe in the 20th Century, Choryński et al. 2012).

For the UoM, examples are taken where the reporting of the environmental impacts includes impacts on water body status (B21), protected areas (B22) or pollution sources (B23) and the impact on economy includes impact on property (B41), infrastructure (B42), land use (B43) or economic activity (B44)⁴. For detailed descriptions of these categories, see section 2.2.

2. Case studies for methodologies at the level of UoM

2.1. Number of flood events reported

Two types of flood events are reported in the preliminary flood risk assessment (PFRA): past and potential future events. For the purpose of this review, only the past events have been included in the review. A summary of the PFRAs of the Units of Management (UoM) included in the study is shown in Table 2.1, with a reference to

² <http://cdr.eionet.europa.eu/>

³ <http://cdr.eionet.europa.eu/>

⁴ In the reporting sheets for the PFRA were the fields ‘TypeEnvironment’ and ‘TypeEconomic’ where member states had to choose from an enumeration list. Besides the options above, there were also: For environment: ‘Environment’ (B20), ‘Other’ (B24) and ‘not applicable’ (B25) For economic: ‘Economic’ (B40), ‘Other’ (B45) and ‘not applicable’ (B46) The meaning of the codes B20 and B40 in relation to the (more detailed) codes B21–B25 and B41–B46 is one of the remaining questions after this exercise.

the xml file containing the information, and available from the Central Data Repository (CDR) on the EIONET website on 01/05/2013.

Each flood event is assigned a unique Flood Event Code (FLEC) and an associated Date of Commencement (DOC). It was found that for a number of UoMs, the number of unique FLECs and DOCs did not match, suggesting that different FLECs (in a one-to-many relationship) were assigned to the same meteorological events when impacting in several distinct locations. A summary of the number of unique FLECs and DOCs for each UoM is shown in Table 2.2.

Table 2.1: Units of Management (UoM) explored as example for the methodologies used for the preliminary flood risk assessment (PFRA)

Country	UoM Code	River basin (English name)	File name in CDR
Bulgaria	BG2000	Black Sea River Basin District	BG_BG2000_PFRA_20130307.xml
Bulgaria	BG3000	East Aegean River Basin District	BG_BG3000_PFRA_20130305.xml
Bulgaria	BG4000	West Aegean River Basin District	BG_BG4000_PFRA_20120928.xml
Czech Republic	CZ1000	Danube	CZ_1000_PFRA_20120321.xml
Czech Republic	CZ5000	Elbe	CZ_5000_PFRA_20120321.xml
Czech Republic	CZ6000	Oder	CZ_6000_PFRA_20120321.xml
Finland	FIVHA2	Kymijoki-Gulf of Finland River Basin District	FIVHA2_PFRA_20120322.XML
Finland	FIVHA3	Kokemäenjoki-Archipelago Sea-Bothnian Sea River Basin District	FIVHA3_PFRA_20120322.XML
Finland	FIVHA5	Kemijoki River Basin District	FIVHA5_PFRA_20120322.XML
Germany	DE5000	German Elbe	DE5000_PFRA_20120307.xml
Germany	DE6000	Oder	DE6000_PFRA_20120307.xml
Romania	RO1	Banat hidrographical (sic) area	RO1_PFRA_20120322.xml
Romania	RO2	Jiu River Basin	RO2_PFRA_20120322.xml
Romania	RO3	Olt River Basin	RO3_PFRA_20120322.xml
Romania	RO4	Arges-Vedea hydrographical area	RO4_PFRA_20120322.xml

Country	UoM Code	River basin (English name)	File name in CDR
Romania	RO5	Ialomita-Buzau hydrographical area	RO5_PFRA_20120322.xml
Romania	RO6	Danube Basin	RO6_PFRA_20120322.xml
Romania	RO7	Mures River Basin	RO7_PFRA_20120322.xml
Romania	RO9	Somes-Tisa hydrographical area	RO9_PFRA_20120322.xml
Romania	RO10	Siret hydrographical area	RO10_PFRA_20120322.xml
Romania	RO11	Prut-Barlad hydrographical area	RO11_PFRA_20120322.xml
Slovakia	SK4000	Danube	SK4000FD_PFRA_20120801.xml
Spain	ES010	Minho	ES010_PFRA_20120123.xml
Spain	ES014	Galician Coast	ES014_PFRA_20120305.xml
Spain	ES030	Tagus	ES030_PFRA_20120321.xml
Spain	ES063	Guadalete and Barbate	ES063_PFRA_20120322.xml
Spain	ES064	Tinto, Odiel and Piedras	ES064_PFRA_20120322.xml
Spain	ES091	Ebro	ES091_PFRA_20130204.xml

Table 2.2: Numbers of Flood Event Codes (FLEC) and Dates of Commencement (DOC) for different Units of Management (UoM)

Country	UoM	Number of FLEC	Number of DOC	Oldest reported event	Most recent reported event
Bulgaria	BG2000	222	98	02/07/1914	17/12/2010
Bulgaria	BG3000	192	126	31/03/1900	08/05/2012
Bulgaria	BG4000	101	30	02/06/1954	05/12/2010
Czech Republic	CZ1000	5	5	06/07/1997	17/05/2010
Czech Republic	CZ5000	9	9	19/08/1974	07/08/2010
Czech Republic	CZ6000	4	4	06/07/1997	07/08/2010
Finland	FIVHA2	2	2	27/07/2004	08/01/2005
Finland	FIVHA3	2	2	09/01/1975	12/08/2007
Finland	FIVHA5	1	1	25/05/2005	25/05/2005
Germany	DE5000	163	40	1717*	23/01/2011
Germany	DE6000	3	3	1872*	30/11/1912
Romania	RO1	39	3	05/04/2000	15/04/2005

Country	UoM	Number of FLEC	Number of DOC	Oldest reported event	Most recent reported event
Romania	RO2	10	1	12/07/1999	12/07/1999
Romania	RO3	23	6	01/07/1975	09/07/2006
Romania	RO4	45	8	08/07/1970	21/09/2005
Romania	RO5	17	4	22/06/1999	20/09/2005
Romania	RO6	1	1	22/09/2005	22/09/2005
Romania	RO7	74	9	13/05/1970	23/08/2005
Romania	RO9	33	4	10/05/1970	26/07/2008
Romania	RO10	72	19	12/05/1970	25/06/2010
Romania	RO11	26	7	17/06/1985	21/06/2010
Slovakia	SK4000	301	42	30/01/2010	21/12/2010
Spain	ES010	400	218	24/11/1905	06/01/2011
Spain	ES014	169	71	1584*	08/01/2011
Spain	ES030	491	177	849*	25/10/2011
Spain	ES063	31	23	761*	30/11/1996
Spain	ES064	35	31**	01/09/1907	27/09/1997
Spain	ES091	1952	434***	15/10/1156	10/08/2010

* Only year of occurrence reported.

** Some events have no recorded date of occurrence (-9999)

There is a marked difference in the numbers of events that are reported by individual Member States and UoMs. For example, Finland has reported only 2, 2 and 1 flood events for the three UoMs investigated. In contrast, Spain has reported several hundreds of events for most UoMs, up to 1952 events for ES091 (Ebro). The number of reported events will be conditional on a number of factors such as size of the basin area covered by a UoM (a larger area is more likely to observe more events) and the time span covered by the data bases containing information about past events.

Most UoMs report relatively recent events from the past four decades (roughly from early 1970s onward). UoMs in Germany and Spain have included events going much further back in time; the oldest event from Germany is dated 1717 (the great Christmas flood), whereas Spain has information on events going back as far as the year 761.

2.2. Structured classification of impacts

Never before the reporting on past floods as part of the Preliminary Flood Risk Assessment (PFRA) under the Floods Directive, information of the impact of flooding was available in such structured way. Not only gives the PFRA reporting information on affected people and occurring damages to man-made structures, it also describes the type of environmental impacts and impacts on cultural heritage.

Reporting of impacts for each flood event follows a pre-defined set of codes and definitions, shown below for Impacts on Human Health (B10–B14), Environmental impacts (B20–B25), Impact on Cultural Heritage (B30–B34) and Economic Impacts (B40–B46):

- B10: Human Health (Social)
- B11: Human Health: Adverse consequences to human health, either as immediate or consequential impacts, such as might arise from pollution or interruption of services related to water supply and treatment, and would include fatalities.
- B12: Community: Adverse consequences to the community, such as detrimental impacts on local governance and public administration, emergency response, education, health and social work facilities (such as hospitals).
- B13: Other
- B14: Not applicable

- B20: Environment
- B21: Waterbody Status: Adverse consequences for the ecological or chemical status of surface water bodies or chemical status of ground water bodies affected, as of concern under the WFD. Such consequences may arise from pollution from various sources (point and diffuse) or be due to hydromorphological impacts of flooding.
- B22: Protected Areas: Adverse consequences to protected areas or waterbodies such as those designated under the Birds and Habitats Directives, bathing waters or drinking water abstraction points.
- B23: Pollution Sources: Sources of potential pollution in the event of a flood, such as IPPC and Seveso installations, or point or diffuse sources.
- B24: Other potential adverse environmental impacts, such as those on soil, biodiversity, flora and fauna, etc.
- B25: Not applicable

- B30: Cultural Heritage
- B31: Cultural Assets: Adverse permanent or long-term consequences to cultural heritage, which could include archaeological sites / monuments, architectural sites, museums, spiritual sites, and buildings.
- B32: Landscape: Adverse permanent or long-term consequences on cultural landscapes, that is cultural properties which represents the combined works of nature and man, such as relics of traditional landscapes, anchor locations or zones.
- B33: Other
- B34: Not applicable

- B40: Economic
- B41: Property: Adverse consequences to property, which could include homes.
- B42: Infrastructure: Adverse consequences to infrastructural assets such as utilities, power generation, transport, storage and communication.
- B43: Rural Land Use: Adverse consequences to uses of the land, such as agricultural activity (livestock, arable and horticulture), forestry, mineral extraction and fishing.
- B44: Economic Activity: Adverse consequences to sectors of economic activity, such as manufacturing, construction, retail, services and other sources of employment.
- B45: Other
- B46: Not applicable

For this report, the focus is on the economic and environmental impacts of flooding. A summary of the total number of recorded flood events together with the number of entries into each of the above Environmental and Economic categories identified in the 29 Units of Management (UoMs) is shown in Table 2.3.

As will be explained in chapter 3, especially the understanding of B20 (Environment impact) and B40 (Economic impact) is not crystal clear when the reporting in different member countries for a specific flood event is looked at in more detail.

Table 2.3 makes clear that Economic impact is being reported less frequently as ‘not applicable’ (code B46) than Environmental damage (code B25). It is not clear if this is because environmental damage indeed occurs less frequently ('not applicable' interpreted as 'was given attention but could not be observed'), or if there is an inherent bias in the data because economic impacts were traditionally recorded (e.g. damage to infrastructure or property) whereas environmental damage was considered less important and more difficult to quantify ('not applicable' interpreted as 'no data available'). No events (in this case study) included reporting under B24 (Other potential adverse environmental impacts, such as those on soil, biodiversity, flora and fauna, etc.) and only 1% of events was recorded under B45 (other economic impacts), perhaps suggesting that the Economic categories covers the majority of the types of economic impacts incurred from flooding.

While the overview of reported events in Table 2.3 provides some information on the classification of consequences, it is clear that there are differences between countries in the frequency of reported events. The different reporting frequency can be the result of several factors, including: natural spatial differences in the frequency of large events, the vulnerability of different regions to flood damage, differences in the classification of events, and differences in available information of damages caused by past events. As accounts of large and damaging flood events can be found for most countries in Europe (Castellari et al. 2012; Kundzewicz 2012; e.g. chapter of Brázdil et al. 2012), it is considered most likely that the differences reflect differences in the classification and availability of information from past events.

Table 2.3: Summary of Environmental and Economic damages reported in the Preliminary Flood Risk Assessment (PFRA)

Country	UoM	Number of FLEC	B20	B21	B22	B23	B24	B25	B40	B41	B42	B43	B44	B45	B46
Bulgaria	BG2000	222	1					221	5	153	147	91	55		3
Bulgaria	BG3000	192			46	29		134	18	62	122	75			30
Bulgaria	BG4000	101	96			5			101						
Czech Republic	CZ1000	6		4	4	4		1		4	4	4	4		1
Czech Republic	CZ5000	9		7	7	7		2		8	8	8	8		1
Czech Republic	CZ6000	4		4	4	4				4	4	4	4		
Finland	FIVHA2	2	1	1		1		1	2	2	2	1			
Finland	FIVHA3	2						2	2	2	1	1	2		
Finland	FIVHA5	1						1	1	1	1				
Germany	DE5000	163	98	3		2		62	100	20	22	41	13		
Germany	DE6000	3	3						3						
Romania	RO1	39	1	12				26	2	36	29	28	11		
Romania	RO2	10		1				9		10	10	9	2		
Romania	RO3	23	2	1				20	2	21	20	15	6		
Romania	RO4	45		21				31		43	44	41	22		
Romania	RO5	17	1	12				5	1	17	17	14	1		
Romania	RO6	1		1	1					1	1				
Romania	RO7	74		1				73		73	67	37	27		
Romania	RO9	33	2	5		1		27	2	31	30	28	4		
Romania	RO10	72	1	5		1		68		72	59	48	14		
Romania	RO11	26		5		5		17		23	21	25	7		
Slovakia	SK4000	301				184		117		286	308	297	229	14	
Spain	ES010	400	3		18			379	152	28	113	28	5		74
Spain	ES014	169	1			2		166	126	15	25	2	2		1
Spain	ES030	491		5				486	210	145	63	72	1		
Spain	ES063	31						31	14	6	8	1			2
Spain	ES064	35						35		3	31	1			
Spain	ES091	1952	28	21				5861	2311	697	1349	1544	9		

2.3 Background information provided on the used methodologies on the level of the Units of Management

In addition to the general assessment of Table 2.3, a more detailed assessment of five selected Preliminary Flood Risk Assessments (PFRAs) was undertaken, highlighting in particular the differences in procedures and classification of the flood events employed by different Member States. The five PFRAs were selected to represent five different countries (Bulgaria, Czech Republic, Germany, Slovakia and Spain) and also PFRAs that include a reasonably large number of events. The summary of the assessment is shown Annex I. Annex I is primarily based on the information provided in the concluding sections of the PFRA-files (under header 'Summary information'). References to websites and supporting documents as provided in the PFRA-files were checked. For the Czech and German cases this extra step resulted in additional information, used in the table and included in the reference list. Translations were obtained by Google Translate. In some instances, the translation results were not fully understood. Because of the resulting differences in levels of understanding, and also because of the limited number of documents and the small number of Units of Management (UoMs) investigated, Annex I should only be seen as a first illustration of similarities and differences.

Similarities:

- for all UoMs information on procedures followed and criteria and thresholds used is available;
- all UoMs have used a similar approach, as requested by the Floods Directive, in collecting and presenting the available information on past floods;
- the main criteria and sub criteria used to assess the adverse effects of floods are the same or at least similar in the five UoMs;
- none of the PFRA-files explain how economic and ecological impacts of past floods were categorised in the available types of impacts.

Most prominent differences (in this limited sample of five UoMs):

- the level of detail provided in the PFRA-files on procedures and criteria used varies widely;
- the time horizon of looking back at past floods. In ES010(Minho Basin, Spain) all information available on any flood event in the past was reported, while in CZ5000 (Elbe, Czech Republic) and SK4000 (Danube, Slovakia) all information before 1997 was discarded because of incompleteness;
- the types of floods considered: the choices are justified by occurrence (or lack thereof) of other types of floods than fluvial floods. Flash floods (although sometimes difficult to distinguish from pluvial floods) are explicitly addressed in CZ5000 and ES010. Special floods (notably as a result of dam failures) receive special attention in CZ5000. DE5000 (German Elbe) states that only fluvial floods are relevant.
- the criteria that were used to determine whether a flood is significant vary widely, according to Annex I. However, due to possible incompleteness of our

information, this is only a preliminary conclusion. An analysis of how the different approaches are or are not rooted in different conditions is lacking at this point, as is an enquiry if these different approaches lead to significantly different results.

It is clear from the UoMs studies scrutinized in this study that the absence of a common set of criteria is a potential reason for differences in the reporting frequency. However, the survey reported in Annex I does not include an assessment of the availability, and ease of access to, reliable information on the consequences of past events, which is expected to also vary between countries. However, it appears that the different MS have gone through a similar process of collating and reporting relevant information that was available.

3. Case studies for flood events

Where in chapter 2 the entry point is to look at the number of reported events and at methodologies, this chapter takes a selection of individual events as the entry point. Based on a Catalogue of Large Floods in Europe in the 20th Century (Choryński et al. 2012) 19⁵ events are selected to have a closer look at over the different affected Units of Management (see Annex II).

As written in more detail in EEA et al. (2013) the different global databases like the ones from CRED (EM-DAT), MunichRe (NatCatService) and Dartmouth Flood Observatory use different criteria to include events. Rather than exploring the information in each of them, for this case study we use the chronology of great floods in Europe during the 20th century (Choryński et al. 2012). General conditions for inclusion in this list of 100 events are a number of fatalities greater than or equal to 20, or the total material damage greater than or equal to 1 billion US\$ (inflation-adjusted).

Besides the 3 global databases mentioned above, the list also contains large events mentioned in studies but not in any of these databases, especially for older events like the flood of January 1910 in Paris, France or the floods in October 1910 and March 1924 in Salerno and the Amalfi Coast.

During the previous phases of this project, it was often mentioned in the Common Implementation Strategy of the Water Framework Directive⁶ working group on floods (see EEA 2012, p.51 for more details about this working group) that the available information on Europe in global databases is not suitable for a pan-European assessment. This expression can be underpinned and is confirmed by looking in more detail to the chronology of great floods in Europe, where even for the twenty deadliest and 20 costliest floods in Europe during the 20th century several items are only reported in

⁵ One of these items (for 2010) is the combination of 3 different records in the Chronology of great floods in Europe during the 20th century as a distinction based on dates was not possible for all involved UoMs

⁶ For the work programme 2013–2015 called Common Implementation Strategy of the Water Framework and Floods Directive

one of these global databases even if the theoretical criteria for inclusion in other databases are met.

3.1 Incomplete information

As the global databases are not suitable for an overview of the large floods in Europe during the last decades, an alternative source of information is required. The first and foremost promising source of information is the reporting about past floods under the Preliminary Flood Risk Assessment (PFRA) for the Floods Directive.

But at the same time the PFRA alone cannot serve as the only source. Although there's not much difference in the type of information provided under art. 4 of the floods directive compared to the information under art. 13§1a, for those areas where art. 13§1b is applied detailed and/or comparable information is missing.

Being a truism, but a comprehensive overview of flooding in Europe needs to include these territories not part of EU27⁷ where PFRA reporting is not applicable. Complementing information can be prefilled in the set-up of a European Flood Impact Database as for around 90%⁸ of Europe information on past floods exists in national and regional databases (EEA et al. 2013).

For several of the events in this case study, more than one country mentioned as affected in the global databases. However the event cannot always be found in the PFRA past floods reporting of all UoMs expected to be significantly affected. Some streamlining in which events to include can benefit from the work actually drafted by EEA and ETC/CCA (2013) about "*What makes flood events significant for the European policies? An analysis of threshold-based criteria*".

3.2 The different types of impact

As written in section 2.2 of this report, more detailed information than ever on the type of impacts is available in a structured way due to the Preliminary Flood Risk Assessment (PFRA) reporting.

For older events, e.g. floods in Poland in 1934, only the general classes for impact on human health, environment, cultural heritage and economy are used. Or there was an impact for this category or that type of impact was not applicable.

For several Units of Management (UoMs) only one code is given for each of the impact categories (human health, environment, cultural heritage and economy). For other UoMs several of the options are combined in one record.

⁷ The information for this report is compiled before 1 July 2013 when Croatia became the 28th member state of the EU. In this report, the information for Croatia is included in the EEA39 figures, being member and cooperating countries of the EEA.

⁸ 92% for EEA32 member countries, 88% for EEA39 member and cooperating countries.

When the general classes (like B20 for environmental impact and B40 for economic impact) are used, this can mean different things:

- we don't know exactly the detailed impact; or
- it is a combination of different of the subtypes.

Further information has to be found in the methodologies before the data reporting can be included in a European Flood Impact database.

For several records in the database (e.g. Spain 1953, France 1959, Northern and Western Europe 1982, Spain 1987, Austria 2002), the value 'not applicable' is reported for all 4 types of impact. But still they are reported as a significant past floods. Especially when a flood event is described by only one record in the GIS database further attention has to be given to them before including this information into a European database.

3.3 Starting date of an event

Especially in those cases where several areas are along a river stretch are reported with their specific details the flooding over time can be followed from upstream towards downstream. In these cases, it is clear that a flooding recorded in the global databases in month x that can be found in the beginning of month $x+1$ in a downstream area of an international river basin still belongs to the same event.

But in some cases it is difficult to attribute a record in the reporting to an event as described in the global databases. Most prominent example are the series of flooding in Central and Eastern Europe in spring and summer 2010 where a clear split up in the 3 events as described in the Catalogue of Large Floods in Europe in the 20th Century (Choryński et al. 2012) was not possible. In addition these records in the floods catalogue are based on different global databases, including an additional level of uncertainty.

In general, the more detailed reporting under the Preliminary Flood Risk Assessment brings more detailed information but before including in a European flood impact database a detailed check by the member countries is needed to avoid mixing up of flood events.

3.4 Added value of quantitative or class information

The global disaster databases often use quantitative thresholds to decide whether or not to include events in their database or in the classification in catastrophe classes of events. The focus here is on human impact, e.g. EM-DAT, of overall economic losses, e.g. NatCatService or Sigma (see EEA et al, 2013 for details). Due to the nature of their sources, they often have to give (wide) ranges of fatalities and losses.

Where the Preliminary Flood risk Assessment (PFRA) reporting on past floods is structured and detailed in the type of impact, much less quantitative or class information is given. Some examples:

- Given that the global disaster databases have number of fatalities and economic damage for almost all records, it was expected to find some similar type of information in the PFRA reporting. If for October 1973 in Spain 287 fatalities are

- reported following a consistent methodology this information is most probably more accurate than the 300–500 in the databases of EM-DAT and NatCatService.
- But for the event of May 1970 in Hungary and Romania the global disaster databases report 200–215 fatalities in Romania only, while in the PFRA reporting only one third (71) is reported as the sum of fatalities in all records. And for the July 1975 flood in Romania in most of the PFRA records (all except one) the impact on human health is described as not applicable while the global databases have around 60 fatalities.

For several of the flood events in the 20 most deadly events of the 20th century, none or a much lower number of fatalities can be found in the PFRA reporting. Is the same definition used across UoMs and how does this relate to the definitions used in the global disaster databases? And can an empty field on the number of fatalities be interpreted as reporting a 0? Some further clarification is needed before the information can be used.

Even less quantitative information is available in the PFRA reporting of economic impacts. Several countries put an explanatory note in their reporting to explain that they don't provide this type of information (e.g. Austria). But in case monetary information is provided, a further clarification and streamlining of the values is needed before the information can be of any use in a European flood impact database⁹: inflation adjusting or not, which damages to include (only direct damage or also indirect, how to value public goods etc.).

Another way to provide additional information besides the sub-types of impact are the impact classes. But some further guidance in the definition and thresholds (being absolute or relative) of the different impact classes¹⁰ is needed.

Questions remain, as how to understand inconsistencies as e.g. damage class M with a not applicable impact on cultural heritage (B34) (e.g. DE1000 (Danube River Basin District, Germany) for January 1995 and DE2000 (Rhine River Basin district, Germany) for December 1993).

The spatial detail of the PFRA reporting and the structured information on the level of the sub-impacts are large improvements compared to the information in global disaster databases. With a focus not only on fatalities and economic damage but including a wider range of impacts on human health (social impacts), environmental impacts, impacts on cultural heritage and economic impacts, the PFRA reporting on past floods is a strong basis to build a European flood impact database based on events significant on a European level. However, in order to serve as useful, some nominal class information (see footnote 9) or quantitative (including aspects as number of fatalities and/or monetary values) information is needed.

⁹ Without a priori stating that this information should be included. Given the clear statement in some of the PFRA reporting that damage values are not desirable a successful European flood impact database will possibly/probably not include monetary values.

¹⁰ Different impact classes being I: insignificant, L: low, M: medium, H: high, VH: very high, NA: not applicable and U: unknown

For the streamlining across Europe on which events to include, separate suggestions will be made in EEA and ETC/CCA (2013). To complete the information on events with the missing parts, to better define the types of impact and to add quantitative or class information, a task should be started together with the member countries.

4. Concluding remarks

1. On the quality and usefulness of reported information:

- a. This survey indicates that harmonization of reporting on flood risk and flood damage has, to some degree, been achieved.
- b. At the same time, a large degree of heterogeneity in the reported information still exists; both in terms of the amount and level of detail.
- c. These differences in reporting between Member States (MSs) prevent a direct comparison between MSs and Units of Management (UoMs) at the European level at this stage.
- d. The categories B20–B25 as defined for describing the environmental impacts are adequate and appropriate, but extra guidance seems to be required to harmonise reporting habits across the MSs.
- e. The categories B40–B46 as defined for describing the economic impacts are adequate and appropriate, but extra guidance seems to be required to harmonise reporting habits across the MSs.

2. On the need and usefulness of additional data collection and reporting:

- a. It is clear that data and information on past flood events are valuable when trying to assess the current and future levels of risk and impacts. For example, hydrologists rely on long-term monitored river flow to establish the relationship between flood magnitude and frequency of occurrence, typically reported as return periods, which can be extrapolated to estimate the risk of very extreme events (e.g. Castellarin et al. 2012). However, it is well-known that such estimates are associated with very large levels of uncertainty. For example, assessing the rarity of a large event occurring in north west England in November 2009, Miller et al. (2013) found that the best available estimate of the rarity (return period) had a 95% confidence interval ranging from 500 to 17700 years (with the best estimate being 2100 years). This example highlights the need for past data on flood data to help reduce the uncertainty and knowledge gaps that flood managers and decision-makers are currently faced with.
- b. It is therefore of paramount importance that there is a clear link between the information collected and the utility of this information to constrain uncertainties and thus help reaching more informed flood management decisions.
- c. For example, most countries report only relatively recent events, but e.g. Germany and Spain have reported much older events. While

interesting, the utility of data on events dating back several centuries for contemporary decision-making is not immediately obvious. It might be useful when communicating flood risk to show tangible evidence of water level reached in previous events through, for example flood marks on old bridges and buildings. It is also possible that such past information can be incorporated into more formal risk analysis (Brazdil et al., 2012). However, the inclusion of historical flood events is still an area of active research, and consequently there is little or no practical guidance available in Europe on how best to derive the data or how to incorporate the information into a risk analysis.

- d. Before asking Member States to invest in data collection and quality control of past events, it is incumbent to ensure that tools and guidance is available to transform the new data into relevant information for flood managers and planners.

3. In defining the need for additional information, if any, it is important to have a clearly defined purpose for the use of this additional information.

The ambition could e.g. be to be able to:

- a. assess environmental impacts at EU scale and identify areas where targeted flood management interventions could be potentially most effective.
- b. compare environmental impacts to other types of impacts, e.g. through monetarisation of these impacts¹¹.
- c. put environmental impacts of floods higher on the agenda
- d. put details of economic impacts of floods higher on the agenda

4. Recommendations to meet the goals defined in the Introduction

- a. In order to adapt reporting practices so that an overview of flood impacts is achieved at EU level, the following issues are to be considered:
 - i. revised guidance on the use of the categories (including B20–B25 and B40–B46 on the environmental and economic impacts respectively)
 - ii. revised guidance on the criteria to classify floods as 'significant'
 - iii. harmonized approach to the usefulness of collecting (incomplete) data on floods in the far past
- b. In order to adapt reporting practices so that the Preliminary Flood Risk Assessment reporting can be used as a basis for a European Flood Impact Database, the following issues are to be considered:

¹¹ Or any other quantitative or ordinal qualitative methods

- i. The availability of already existing databases, and the potential costs for collection and quality control of data on current and past events.
- ii. Assessment of flood risk between Member States and Units of management (UoMs) need to consider the differences in reported past floods might result from missing or unavailable data rather than actual differences in flood risk.
- iii. Better understanding of how to quantify economic and environmental impacts
- iv. Develop a better understanding of flooding as a probabilistic phenomenon, for example, new flood mitigation measures might not be effective if a future flood exceeds the design specifications. Thus, performance criteria need to consider long-term reductions in risk, where risk involves both the frequency of events as well as the impact of these events.

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Annex I: Summary of five selected PFRA files: Steps in overall approach

	BG3000	CZ5000	DE5000	SK4000	ES10
	East Aegean River Basin District	Elbe	German Elbe	Danube	Minho
Information source(s)	File BG3000_PFRA_20130305.xml, translated by GoogleTranslate	File CZ_5000_PFRA_20120321.xml refers to www.povis.cz , last accessed on 11 sept 2013. Translation by GoogleTranslate. Additional info from (IKSE, 2012).	No info is provided in file DE5000_PFRA_20120307.xml. Reference is made to reports FGG Elbe (2011) ¹² and IKSE (2012) ¹³ on geoportal.bafg.de , last accessed on 11 sept 2013. The findings from these reports are summarized below, translated by the authors	File SK4000FD_PFRA_20120801.xml	File ES010_PFRA_20120123.xml
Steps in the overall approach	<p>The overall approach is carried out by a uniform methodology, approved by the Minister of Environment and Water.</p> <ol style="list-style-type: none"> 1.Data collection on past floods and their consequences 2.Assess reliability of data, process data 3. Identification of major floods and their effects 	<p>Detailed descriptions of the procedures followed are provided in the Report on the preliminary flood risk in the Czech Republic, 2011.The authors were not able to access this information, maybe due to inadequate translations.</p> <p>The main focus is on river flooding. For flash floods outside the river network a</p>	<p>For the Elbe, only one type of flood was considered: Floods caused by surface water bodies. Other types (overland flow, groundwater, dam failures) were not considered in the PFRA-reporting.</p>	<p>Data were used of the period 1997–2010</p> <ol style="list-style-type: none"> 1. GIS analysis of fluvial deposits indicates potential flooded areas 2. 2nd layer with infra, buildings, houses etc. 3. Areas with probable potential significant flood risks determined by expert evaluation; expert's opinion was notably important for 	<ol style="list-style-type: none"> 1.Collection of general information 2. Collection of flooding information in the UoM 3. Determination of potential areas of flood risk 4. Identification of significant potential flood risk areas 5. Final selection of areas with significant potential flood risk

¹² Flussgebietsgemeinschaft Elbe (2011) Information der Öffentlichkeit gemäß § 79 WHG über die Umsetzung der Hochwasserrisikomanagement-Richtlinie (Richtlinie 2007/60/EG) für den deutschen Teil der Flussgebietseinheit Elbe

¹³ Internationale Kommission zum Schutz der Elbe (IKSE) (2012) Abschlussbericht ueber die Erfuellung des 'Aktionsplans Hochwasserschutz Elbe' 2003–2011

	BG3000	CZ5000	DE5000	SK4000	ES10
	<p>4. Combining flood reports into flood events</p> <p>5. Determination of the extent of the flooded area; by hydraulic models and/or geometric data</p> <p>6. Determination of consequences of past floods in the future</p> <p>7. Determination of the potential impact of potential future floods</p> <p>8. Cross-border information exchange</p> <p>9. Public information and consultation</p> <p>10. Supplement information with new data</p> <p>The PFRA-file provides some more detail for each of these steps.</p>	<p>guidance was created. Risks of dam bursts are addressed in dedicated plans; these are not considered in determining areas with potential significant flood risk.</p> <p>In the PFRA-file, four steps are described:</p> <ol style="list-style-type: none"> 1. Analysis of past floods 2. Analysis of the potential effects of past floods in the future 3. Analysis of the effects of measures taken (structural and non-structural) 4. Analysis of the effects of long-term trends (climate change, land use) <p>For the assessments data were used from the period 1997–2010, because earlier data are incomplete.</p>		<p>evaluation of existing flood protection measures</p> <p>4. For future state, climate change effects estimated; effects on subbasin runoff: increase in winter (up to 100%), decrease in summer (down by some 30 a 40 %)</p> <p>5. End result: 559 areas identified, 378 with potential significant flood risk, 181 with likely to actual significant flood risk</p> <p>The PFRA-file provides some more detail for each of these steps.</p>	<p>The PFRA-file provides some more detail for each of these steps.</p> <p>Approach takes floodplains and torrential areas into consideration.</p>
Criteria used to determine whether a flood is 'major' or 'significant'	<p>Significant if the threshold for at least 1 of 4 categories of indicators is exceeded. Categories: human health, business, environment, cultural heritage. The thresholds were defined at national level, but they are not specified in the PFRA-file. The assessment is done separately for each location for which information is available.</p>	<p>Different criteria are used for different types of flood.</p> <p>Fluvial floods:</p> <ol style="list-style-type: none"> 1) at least 'medium probability' (1:100); 2) at this frequency, at least 2000 km² affected area and at least observed at 3 gauges. <p>Flash floods:</p> <ol style="list-style-type: none"> 1) at least 3 casualties or at least 100 million CZK damage <p>Significant groundwater</p>	<p>Because of the regional characteristics, different indicators and different threshold values are used in the constituents. This also means that the indicators listed are not used everywhere. A flood event is classified as significant if one of the items listed as being of regionally-specific significance limit is exceeded. The chance of recurrence of the past floods</p>	<p>Assessment based on flood stages. Stage III: degree of flood expressing real threat to flood the area. (more info under 'other relevant information'; this was not analysed further by the authors, due to inadequate translations).</p>	<p>Indicator calculated, based on impacts on human health (casualties; wounded; evacuated; basic services) and economy (industry; agriculture), with a weight for reliability and exactness of data. Then in a second round, combination with polygons for population density, economic activity, historical factor, land use. Then as threshold the 10% value is chosen.</p>

	BG3000	CZ5000	DE5000	SK4000	ES10
		floods and pluvial floods were not observed. Special floods: at least 3 human casualties.	in a similar form in the future is regarded as a given.		
Approach for determining the adverse consequences of past floods					
General	Assessing the significance is an estimate based on comparison of data with standards. Four categories (see below), several indicators, with threshold criteria	No information is provided on this issue in the PFRA-file. Reference is made to the Report on the preliminary flood risk in the Czech Republic, 2011. The authors were not able to access this information, maybe due to inadequate translations. IKSE (2012) summarises the criteria for potential flood risk listed below	Assessment of adverse consequences is based on the four categories listed below. IKSE (2012) summarises the criteria for potential flood risk listed below	Assessment of adverse consequences is based on the four categories listed below. The PFRA-file refers to regulations addressing data collection and reporting on floods + adverse consequences. These were not analysed in more detail due to inadequate translations.	Assessment of adverse consequences is based on the four categories listed below. Historical data were also collected, but not used in uniform assessments because of heterogeneity.
Environmental adverse consequences	Affected sewage systems; affected water treatment plants; affected protected areas; affected water protection zones IPPC and SEVESO.	Sources in a flooded area, criterion for significance determined on ad hoc basis	Protected areas in accordance with Article 6 WFD, as far as these could be affected by an IPPC installation in the event of a flood (>1). Drinking water protected areas or the affected percentage (>1) Affected PRTR installation (>1)		
Adverse consequences for Human Health	Number of injured and killed people; affected housing; infrastructure of settlements; affected public buildings; affected sources of drinking water	Mean annual number of people affected yearly in a community; significant if at least 25 people per year.	Indicators to assess the extent of impact (significance limits) are the number of listed fatalities (> 1), the population affected by floods (> 100) or the	Quote from PFRA- file: 'number of victims of floods is relatively small and almost always by individual carelessness'	Number of deceased, weight: 32 with data and 8 without Number of wounded, weight: 16 with data and 8 without

	BG3000	CZ5000	DE5000	SK4000	ES10
			number or percentage of affected buildings (> 10), hospitals (> 1), schools (> 1) or other vulnerable infrastructure (> 1).		Number of evacuated, weight: 8 with data and 2 without Housing, weight: 16 with data and 4 Transport infrastructure, high 8, medium 7, low 6, without data 2 Basic services weight: with data 16, without 4
Economic adverse consequences	Business: number of affected sites; affected property; highways; roads; railways; bridges; airports; linear infrastructure; agricultural areas; total economic value	Value of property affected yearly on average; significant if higher than 70 million CZK/year	Number of affected buildings (> 10) Residential areas or areas of mixed use according to ATKIS (> 1) Affected supra-regional transport infrastructures (>1) Number of affected industrial and commercial areas according to ATKIS (> 1). Area of affected cultural landscape, particularly significant land use (>1 km ²) Overarching significance threshold, based on the monetary loss potential. (>500,000 euros).	recurrence time 1:100 - area potentially inundated - existing infra and uses (residential, hospitals, schools, govmt, services, prisons, industrial, agricultural, conservation areas, areas of economic activities that may result in pollution; – flow capacity may be exceeded 1:100 y in residential areas, conservation areas, industr. areas of regional importance; 1:50 y in dispersed residential areas ,local importance; 1:10 y local importance campuses.	Industry weight: with data 4, without 1 Agriculture and livestock weight: without data 4, without any data 2
Adverse consequences for Cultural heritage	Heritage: cultural and historical monuments of UNESCO or national importance	National cultural monuments and heritage affected; significance determined on ad hoc basis	Number of affected UNESCO World Heritage sites (>1) Number of other heritage sites of national importance (>1)		

Annex II: Selected historic floods for case studies on flood event level

1. June–July 1934, Poland
2. October 1953, Spain
3. December 1959, France
4. May 1970, Hungary and Romania
5. October 1973, Spain
6. July 1975, Romania
7. January 1982, Northern and Western Europe (UK, Germany, France)
8. August 1983, Spain
9. November 1987, Spain
10. October–November 1990 former Yugoslavia (Slovenia, Croatia)
11. December 19993, France, Germany, the Netherlands, Belgium, Luxembourg
12. January 1995, Germany, France, the Netherlands, Belgium, Luxembourg
13. June–August 1997, Poland, Czech Republic, Germany
14. May 1999, Germany, Austria, Switzerland
15. August 2002, Germany, Czech Republic, Austria, Italy, Romania, Bulgaria, Slovakia, Ukraine, Hungary and Moldova
16. April–August 2005, Romania and Bulgaria
17. August 2005, Austria, Germany and Switzerland
18. July 2008, Ukraine, Romania and Moldova
19. May, June and August 2010 Central and Eastern Europe
This last one being the aggregation of 3 flood records in the Chronology of great floods in Europe during the 20th century (Choryński et al. 2012):
 - a. May 2010, Poland
 - b. June 2010, Croatia, Germany, Hungary, Romania, Slovakia, Czech Republic, Poland and Austria
 - c. August 2010, Germany, Czech Republic, Poland and Lithuania

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