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PART 1/2

COMMISSION STAFF WORKING DOCUMENT

European Overview- 2nd Preliminary Flood Risk Assessments

Accompanying the document

REPORT FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL

on the implementation of the Water Framework Directive (2000/60/EC), the Environmental Quality Standards Directive (2008/105/EC amended by Directive 2013/39/EU) and the Floods Directive (2007/60/EC)

Implementation of planned Programmes of Measures
New Priority Substances
Preliminary Flood Risk Assessments and Areas of Potential Significant Flood Risk

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List of Acronyms

APSFR	Areas of Potential Significant Flood Risk
EEA	European Environment Agency
EIONET	European Environment Information and Observation Network
FD	Floods Directive
FHRM	Flood Hazard and Risk Map
FRM	Flood risk management
FRMP	Flood Risk Management Plan
MS	Member State
NWRM	Natural Water Retention Measures
PFRA	Preliminary Flood Risk Assessments
RBD	River Basin District (as defined in the WFD)
SEA	Strategic Environmental Assessment
UoM	Unit of Management (as defined in the FD, this overlaps with the RBD)
WFD	Water Framework Directive
WISE	Water Information System for Europe

List of Member States' codes

AT	Austria
BE	Belgium
BG	Bulgaria
CY	Cyprus
CZ	Czechia
DE	Germany
DK	Denmark
EE	Estonia
EL	Greece
ES	Spain
FI	Finland
FR	France
HR	Croatia
HU	Hungary
IE	Republic of Ireland
IT	Italy
LT	Lithuania
LU	Luxembourg
LV	Latvia
MT	Malta
NL	The Netherlands
PL	Poland
PT	Portugal
RO	Romania
SE	Sweden
SI	Slovenia
SK	Slovakia

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1. Executive Summary

This document is an European Union overview of the Member States' updated preliminary flood risk assessments, and identification of areas of potential significant flood risk, according to Articles 4, 5, 14 and 15 of the Floods Directive. These updates were to be reported to the European Commission by March 2019. The document brings together, and discusses, the findings of a review conducted by the Commission that examined each Member State's update individually. The findings for each Member State are published in separate documents. At the time of publication, all Member States have reported information on the implementation of this part of the Floods Directive through the European Environment Agency's Water Information System for Europe. It was not possible to include the update of one Member State, since it reported very late to be included.

The present EU overview aims at strengthening flood risk management in the EU The Commission also collects information to create an EU-wide picture to inform the public on certain aspects of policy. The present document may take therefore a broader perspective than the Floods Directive; the text of the latter being the only benchmark against which a Member States' compliance should be judged.

None of the Member States have made any notable changes to their administrative arrangements. Reports detailing the updated preliminary flood risk assessment have been prepared by all Member States covering all river basins. Nearly all Member States published their preliminary flood risk assessments online.

Overall, compared to the Member States' first preliminary flood risk assessments, half have improved data collection and/or methodologies to carry out preliminary flood risk assessments. In the previous Commission review, no distinction was drawn between the methodologies for the application of the various sub-articles under Article 4. This has now become clearer, however, there is still room for improvement. Therefore, Member States should consider providing clearer information on how Article 4 has been applied in the next update of their preliminary flood risk assessment. To aid this process, a flowchart detailing the possible steps involved is included in this document.

Although the discourse around floods in urban areas and sea level rise has intensified, it is still river floods that are most frequently registered as a source of significant flooding in the EU. The most common mechanism of floods happening was natural exceedance (of e.g. the confines of a river's banks or embankments) and the most common characteristic was flash flooding, i.e. flooding that materialises rather quickly.

All Member States provided at least some information on how past floods have been assessed and the criteria used for defining significance. In some Member States detailed information on how the criteria and methodologies have been applied are lacking, but in others the methodology is clear and detailed. In fact, two thirds of Member States presented strong evidence of a clear methodology for the assessment of past floods. In addition, "expert judgement" has been relied upon to a lesser extent, mainly being used to verify the results of analysis on the basis of local knowledge. More generally, the present review found that some Member States' preliminary flood risk assessments would benefit from a clearer presentation of the methodologies applied to identify flood risk and assess its significance, for past and/or future floods. Nevertheless, in just under half the Member States, the criteria for identifying significant future floods have been updated based on current methodologies.

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An assessment of the information reported on the impact of past floods was not included in the EU overview document (published in 2015) that discussed the Member States' first ever preliminary flood risk assessments under the Floods Directive. This aspect was looked at this time around, also thanks to improved reporting requirements commonly agreed to with the Member States via the Common Implementation Strategy (a platform to cooperate for better implementation of the water acquis). The conclusion is that information on the impact of past floods is being collected, albeit variably. Some Member States do qualitative assessments, while others collect more detailed, quantitative, data. However, in 60% of river basins in the EU there are no data on the costs from flood damages. There is therefore room for improvement since collecting such data aids for example the calculation of costs and benefits and the prioritisation of measures. Considering other policy developments in the areas of disaster risk management and climate change, a more nuanced attention to disaster loss data is therefore strongly advisable.

For the vast majority of Member States there is some or strong evidence that the consequences of future flooding on human health, the environment, cultural heritage and economic activity are being considered. Attention to environment and cultural heritage appears to have risen compared to the past since the percentage of areas of potential significant flood risk where environment and cultural heritage were not found to be relevant dropped by around 10 percentage points.

Long term developments (socio-economic, infrastructure, land use) have been considered in most Member States but with varying degrees of rigour. There is also evidence that all Member States have considered climate change in their preliminary assessments; this is an improvement on the previous comparable review where the case was unclear for over a third of Member States.

2. Introduction and background

The Floods Directive 2007/60/EC (FD) came into force in 2007. It established a framework for flood risk management (FRM) and foresees 6-yearly cycles with the objective to reduce the risk of flood damage in the European Union (EU). The first cycle of implementing the FD covered the period 2010-15. The second cycle covers the period 2016-21. The latter is also the period of implementation of the first Flood Risk Management Plans (FRMPs), which were established by the Member States at the end of the first cycle. The first FRMPs[1], but also the first cycle Preliminary Flood Risk Assessments (PFRAs), the Areas of Potential Significant Flood Risk (APSFRs) identified, and the Flood Hazard and Risk Maps (FHRMs)[2] were sequentially assessed by the European Commission (the Commission). During the second cycle, Member States are required to have reviewed and updated, by 22 December 2018, their first cycle Preliminary Flood Risk Assessments. This is the subject of the present document.

Member States report information to the Commission electronically using dedicated tools and databases developed under the European Environment Agency's (EEA) Water Information System for Europe (WISE). The reporting guidance and relevant digital tools for reporting under the FD[3] have been updated for the second cycle and are available on

[1] https://ec.europa.eu/environment/water/water-framework/impl_reports.htm
[2] https://ec.europa.eu/environment/water/flood_risk/overview.htm
[3] http://cdr.eionet.europa.eu/help/Floods/Floods_2018/index.html

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the European Environment Information and Observation Network's (EIONET) Common Data Repository (CDR)[4].

The tables in this report have been generated from the data and information provided by the Member State. The electronic reporting format includes the requirement for the Member States to select from pre-defined options contained in lists (e.g. a list of criteria for identifying past floods with significant adverse impacts). The Member States selected the options that correspond to their respective situations when reporting to the Commission. In addition to the selection of options, the Member States also reported PFRA studies and internet links to further information and this information has also been evaluated as part of the assessment. This document reflects the situation as reported by the Member States to the Commission before the assessment and with reference to PFRAs prepared prior to the reporting. The situation in the Member States may have altered since then.

This document includes 26 of the 27 Member States[5]. The individual Member State assessment studies, published separately, provide the background to the present EU overview.

Whereas a key role of the Commission is to check compliance with EU legislation, the Commission also seeks information to determine whether existing policies are adequate. The present EU overview and the individual Member States' PFRA reviews conducted by the Commission, aim at strengthening flood risk management in the EU on the basis of good practice, as it emerges from the implementation of the FD by the Member States themselves. The Commission also collects information to create an EU-wide picture to inform the public on certain aspects of policy. The present document (and the individual reviews it is based on) therefore may take a broader perspective than the FD; the text of the latter being the only benchmark against which a Member States' compliance to the FD should be judged.

3. Overview of timeliness and completeness of the information reported

Member States report information to the Commission electronically using dedicated tools and databases developed under the European Environment Agency's (EEA) Water Information System for Europe (WISE). The information provision requirements included in the WISE/EIONET (European Environment Information and Observation Network) electronic reporting has been agreed with the Member States and is reflected in "Reporting Guidance" documents. The reporting guidance and relevant tools for reporting under the FD have been updated for the second cycle and are available on EIONET[6]. The information reported to WISE was the starting point for the assessment of Member States' second cycle PFRAs. The majority of the statistics presented are based on information reported to WISE. Assuming that the Member States accurately transferred the information contained in their PFRAs to EIONET[7] and barring any undetected errors in the transfer of this information

[4] The European Environment Information and Observation Network (EIONET) is a partnership network of the European Environment Agency (EEA) and its 38 member and cooperating countries. Reportnet is EIONET's infrastructure for supporting and improving data and information flows. The Central Data Repository (CDR), where Member States report, is part of the Reportnet.

[5] Bulgaria did not report in time to be included in the Commission's assessment of second cycle PFRAs.

[6] http://cdr.eionet.europa.eu/help/Floods/Floods_2018/index.html

[7] Member States insert their data and information in so-called "reporting sheets" resembling questionnaires. These are the same for all Member States and are not customisable.

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to WISE, arising from the use of interfacing electronic tools, these statistics should accurately reflect the content of the PFRAs.

3.1. Timeliness of the reported information

Table 1 shows the time periods over which the Member States reported information to the EIONET CDR. According to the timescales of the FD, information on the second PFRAs should have been reported by 22 March 2019. None of the Member States completed their reporting by March 2019 and only one third of Member States commenced reporting in March 2019. However, over half completed a substantial part of their reporting within a few months from March 2019. It should be noted however that due to an update in the folder structure of the reporting infrastructure and due to a later issue with the number of processes that the servers could handle, Member States were given until 30 August 2019 to complete their submissions. More generally, reasons for late reporting include one or more of the following: delayed preparation of PFRAs, data quality control issues or latent bugs in the reporting infrastructure, corrections and updates to previous submissions or provision of supplementary information.

As can been seen from Table 1, eight Member States[8] started uploading information in March 2019, but no Member States had completed their reporting by this date. Denmark and the Netherlands were the first Member States to complete reporting (in June 2019) followed by Slovakia in July 2019. By December 2020 all Member States, with the exception of Bulgaria, Cyprus, Greece, and Malta, had uploaded the bulk of the information required to allow the assessments to commence. It should be noted that some Member States updated the information reported after the assessments had commenced. By way of example only, Austria provided updated files in March 2021, and Latvia provided updated spatial data for APSFRs in January 2021. Greece, Cyprus and Malta reported by April 2021. At the time of writing, Bulgaria had not yet completed its reporting.

[8] BE, FR, HU, LU, LV, NL, PL and SE.

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Table 1: Dates when Member States reports submitted into the EIONET CDR (for illustrative purposes only)

	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21
AT				■		■									■										■					
BE	■			■	■	■	■						■																	
BG	Did not report in time to be assessed by the Commission																													
CY																									■	■				
CZ			■			■	■																							
DE					■																			■						
DK				■																										
EE				■	■	■	■												■			■								
EL																					■	■	■	■						
ES							■	■					■									■		■					■	
FI		■			■	■																								
FR	■		■									■					■	■	■	■										
HR						■					■																			
HU	■					■							■																	
IE							■												■	■										
IT			■	■	■		■					■		■			■			■	■									
LU	■				■	■																■								
LT																	■													
LV	■	■	■		■				■					■									■							
MT																			■						■	■				
NL	■		■	■																										
PL	■										■	■								■	■									
PT					■	■	■	■				■	■									■								
RO						■	■																							
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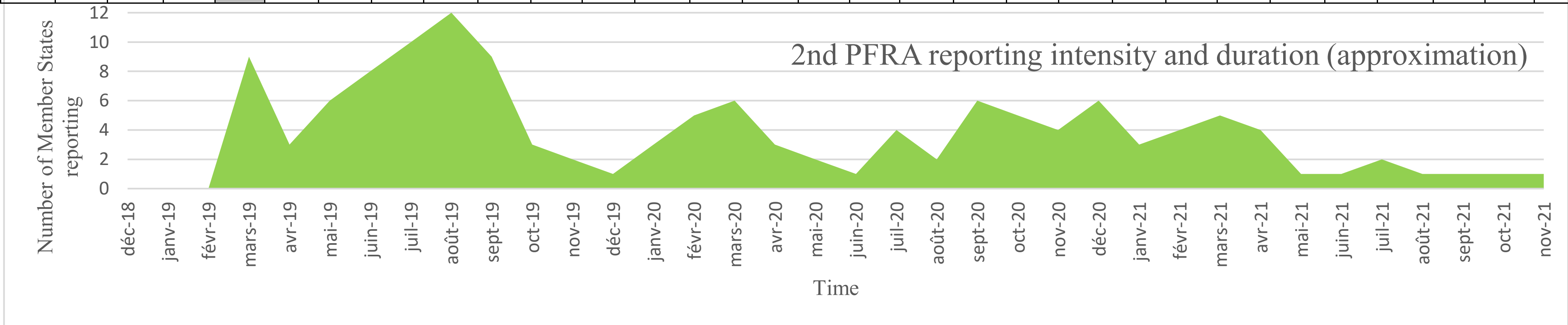
SK					■																									



3.2. Completeness of the reported information

Table 2 shows the information reported by each Member State to the EIONET CDR. It should be noted that the FD does not require information about CAs or UoMs to be reported for every cycle if it has not changed. As a result, many Member States have not needed to report information on CAs or UoMs. This may also explain why some UoMs have not reported spatial data.

Twenty five of the 26 Member States that reported information presented evidence to show that a PFRA has been prepared for all UoMs. The exception is Spain where no PFRA was reported for the Balearic Islands (ES110) in time for the assessment[9]. The approach to preparing the PFRA varied between Member States. Those Member States with only one UoM[10] understandably prepared only one PFRA. Fourteen Member States[11] prepared one PFRA document that included all the UoMs in the Member States. Seven Member States[12] produced PFRAs for each UoM. In Finland, France and Portugal a nationally agreed template was used. In Italy, PFRAs were prepared for each River Basin District (RBD) covering several UoMs against a nationally agreed template.

The length and clarity of the PFRAs varied between the Member States. Some were clearly written and explained the methodology that has been used in way that would be easy for the general public to understand. Others were written in rather technical language that would be difficult for the layman to interpret, whilst others did not contain sufficient information to allow the adequacy of the methodologies employed to be determined. Some included hyperlinks to where more detailed methodological information could be found. Some included in-depth analysis of certain aspects of the PFRA, e.g. past floods[13] or climate change, but it was not always clear how this information had then been used in the assessment of flood risk. Most of the Member States published the PFRA online. One Member State had not made their PFRA available in this manner, whilst another had already consigned the documents to an archive server.

[9] The PFRA for ES110 (Balearic Islands) was adopted by the authorities in June 2021, http://www.caib.es/sites/aigua/es/inf_pub_epri_2o_ciclo/, but not reported in time for this document.
[10] CY, HU, MT.
[11] AT, CZ, DK, EE, EL, HR, IE, LT, LU, LV, NL, PL, SE and SK. SK also produced individual PFRAs for each UoM.
[12] BE, DE, ES, FI, FR, PT and RO.
[13] See case study 1 at the end of this document.

Table 2: Completeness of the information reported to EIONET Central Data Repository by Member States

MS	CAs UoMs[14]	PFRA	APSFRs	APSFR Tracking	PFRA past events (spatial)	PFRA future events (spatial)	APSFR (spatial)
AT							
BE							
BG	Did not report in time to be assessed by the Commission						
CY							
CZ					1 of 3		
DE					7 of 10	5 of 10	
DK				2 of 4			
EE				2 of 3	2 of 3	2 of 3	2 of 3
EL							
ES		24 of 25	24 of 25	24 of 25	24 of 25	24 of 25	24 of 25
FI				6 of 8		6 of 8	6 of 8
FR							
HR							
HU							
IE							
IT			46 of 47		45 of 47	45 of 47	46 of 47
LT							
LU							
LV							
MT							
NL							2 of 4
PL		7 of 9	6 of 9	6 of 9	6 of 9	6 of 9	6 of 9
PT							
RO						11 of 12	
SE			5 of 6	3 of 6			5 of 6
SI				1 of 2			
SK						1 of 2	

Key:

Data reported for all UoMs
Data reported for some UoMs
Data not reported

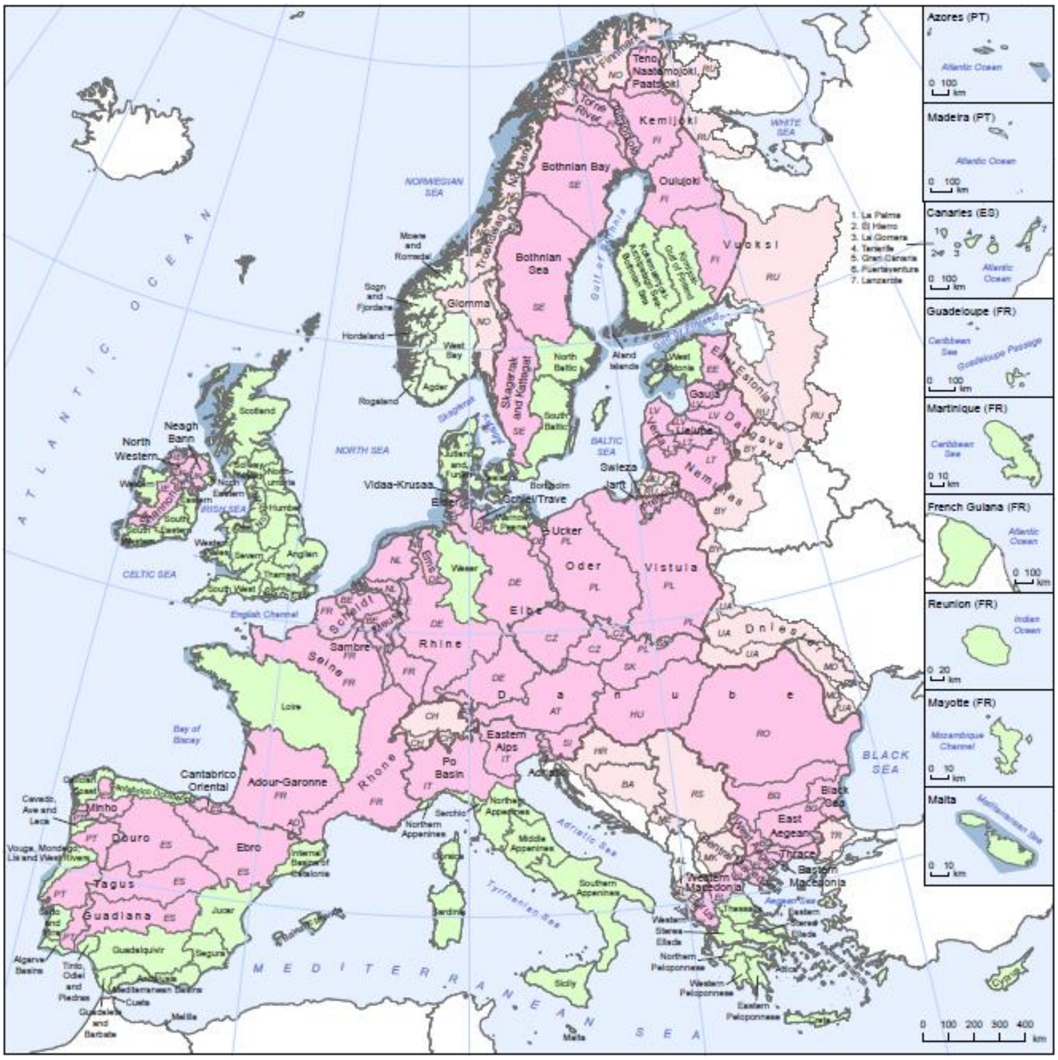
Notes:
EE: No floods occurred in one UoM (EE3) therefore no APSFRs have been identified.
ES: No data was reported for UoM ES110 in time for the assessment.
HU: No change in spatial data for future floods since first cycle.
FI: No significant flood risk identified in two UoMs (FIVHA1 and FIWDA).
PL: No data reported for two UoMs (PL3000, PL4000). Incomplete data for PL8000 and PL9000.

[14] Where no information has been reported it has been assumed that the UoMs and CAs have remained the same as during the first cycle.

4. UoMs and Competent Authorities

The FD provides that Member States may make changes to their administrative arrangements which include their Units of Management[15] (UoMs) and their relevant Competent Authorities (CAs). If such changes occur, Member States are required to notify the Commission within three months. None of the Member States have reported that they have made notable changes to administrative arrangements. The UoMs are shown in Figure 1.

Figure 1: Map of UoMs



- Units of Management/International River Basin Districts (within European Union)
- Units of Management/International River Basin Districts (outside European Union)
- National River Basin Districts (within European Union)
- Countries (outside European Union)
- Coastal Waters

Source: WISE, Eurostat (country borders)

[15] In the sheer majority of UoMs these coincide with the WFD's River Basin Districts. There are 206 UoMs in the EU. A list is included as Annex A.

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5. Implementation of Article 4

5.1. Introduction to Article 4.2 of the Floods Directive

Article 4.2 of the FD requires Member States to undertake a preliminary flood risk assessment (PFRA). The Directive requires that PFRA be 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. The PFRA shall include at least the following:

- 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 (Article 4.2(a));

- A description of the floods which have occurred in the past and which had significant adverse impacts on human health, 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 (Article 4.2(b));

- A description of the significant floods which have occurred in the past, where significant adverse consequences of similar future events might be envisaged (Article 4.2(c)); and

- Where the specific needs of the Member States require it, 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 man-made flood defence infrastructures, the position of populated areas, areas of economic activity and long-term developments including the impact of climate change on the occurrence of floods (Article 4.2(d)).

Figure 2 shows the relationship between Articles 4.2 (b), (c) and (d), and Article 5 (the selection of APSFRs) and depicts the recommended steps in order to carry out a full Article 4 and Article 5 analysis.

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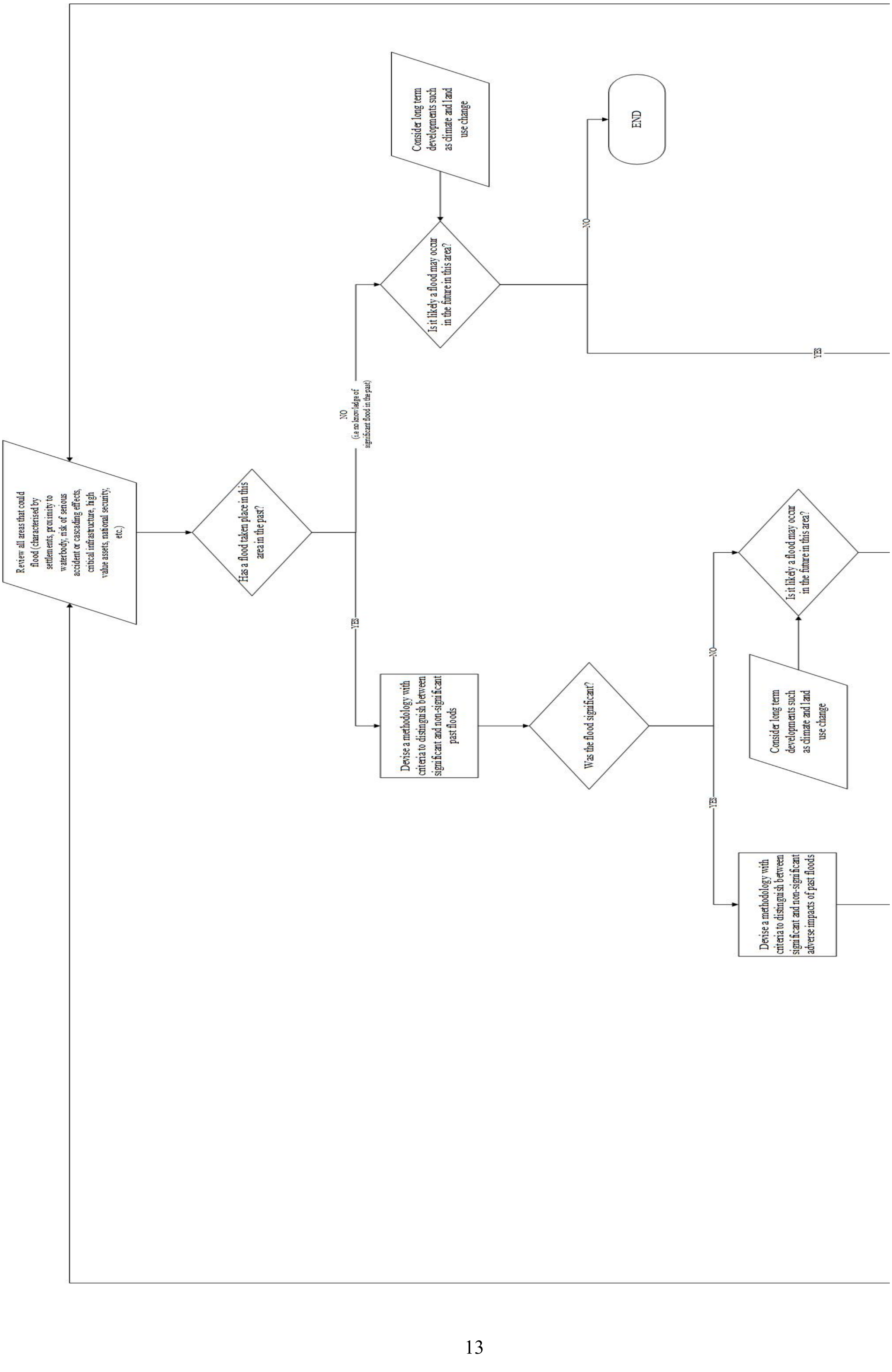
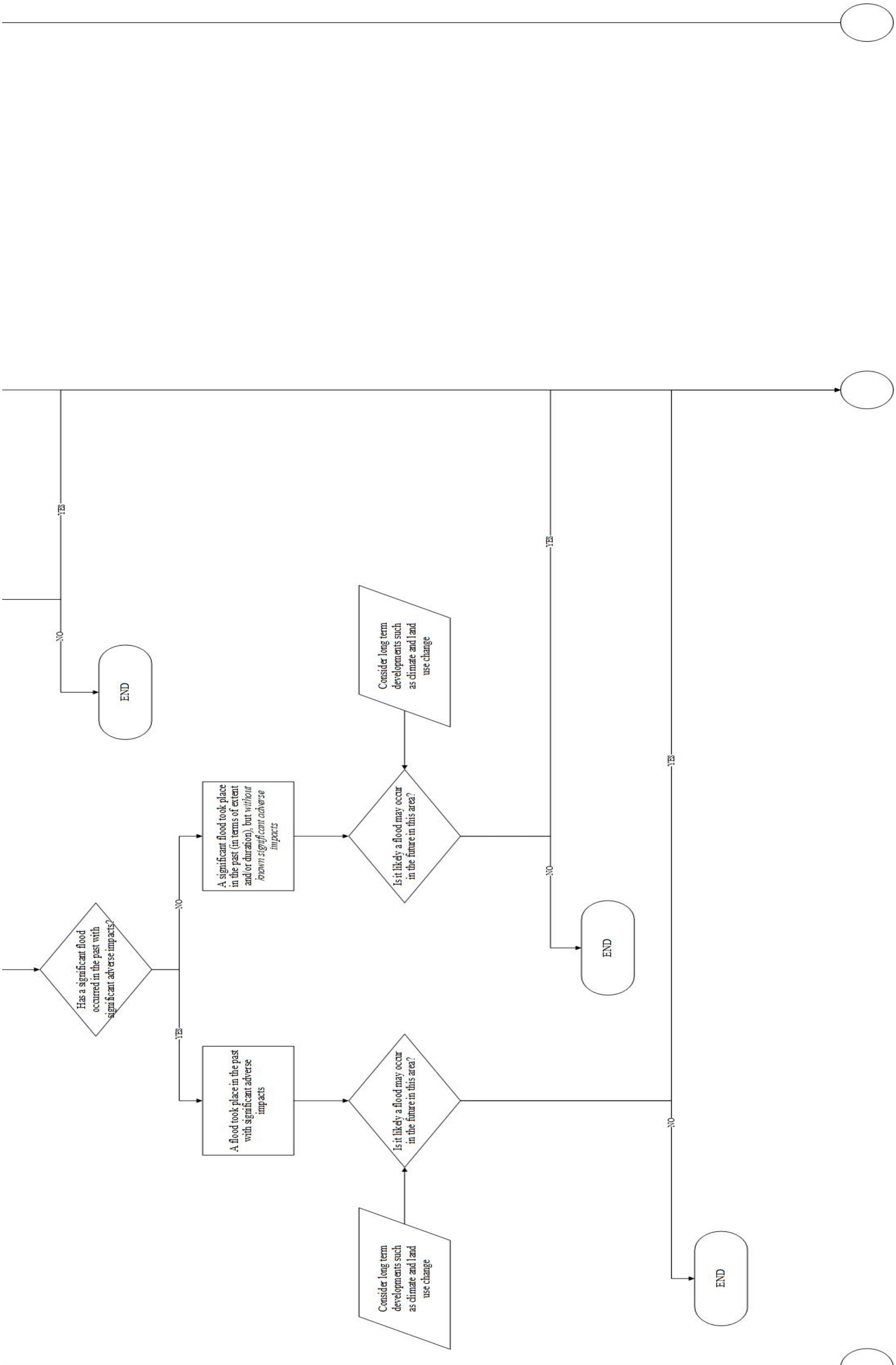
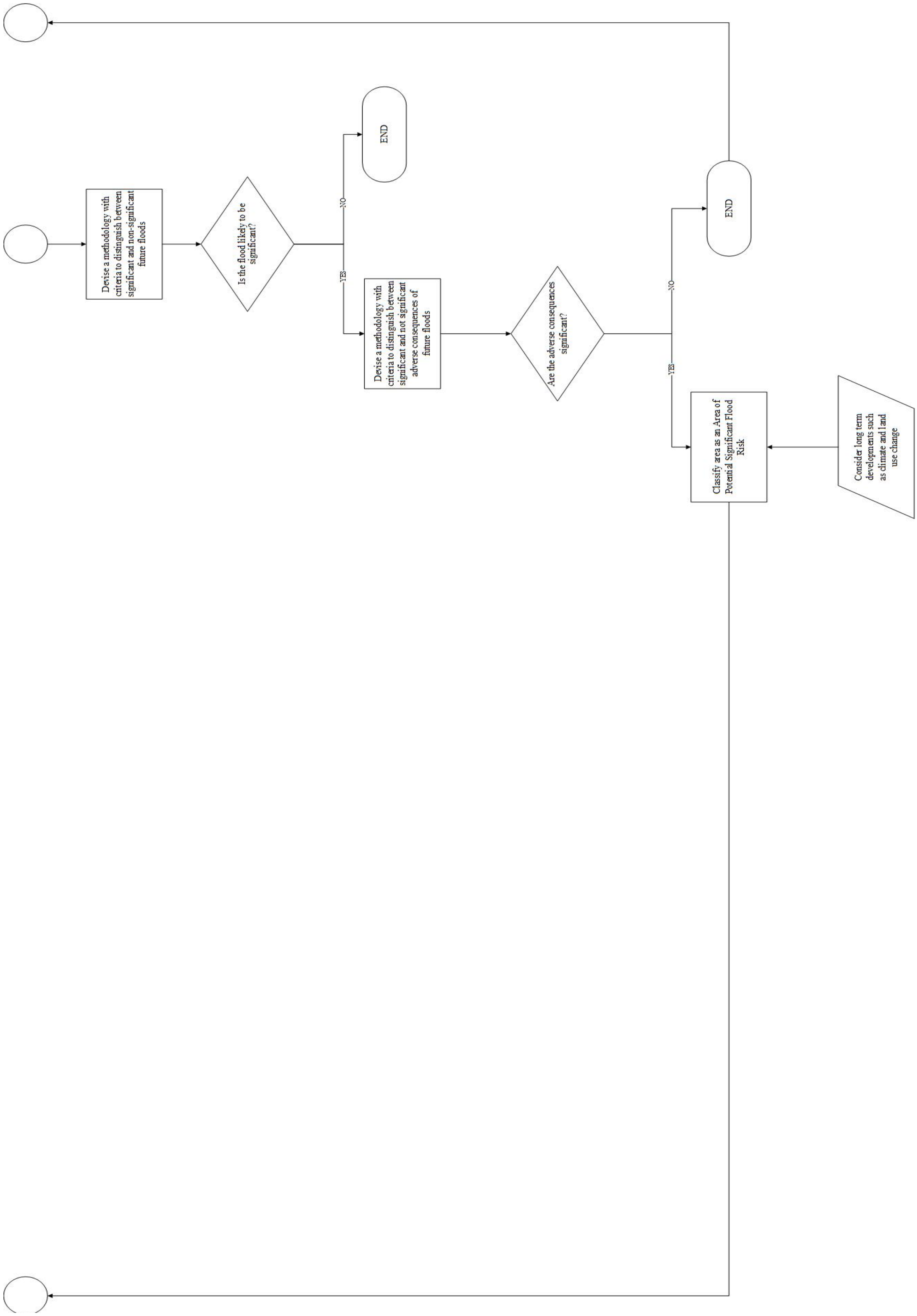
Figure 2 (this and next pages): Flow charts showing the relationship between Article 4.2 (b), (c) and (d) (the PFRA) and the Article 5 (the selection of APSFRs)




Has a significant flood occurred in the past with significant adverse impacts?
YES
NO
A flood took place in the past with significant adverse impacts
A significant flood took place in the past (in terms of extent and/or duration), but *without known significant adverse impacts*
Is it likely a flood may occur in the future in this area?
Is it likely a flood may occur in the future in this area?
Consider long term developments such as climate and land use change
Consider long term developments such as climate and land use change
YES
NO
YES
NO
YES
NO
END
END
END



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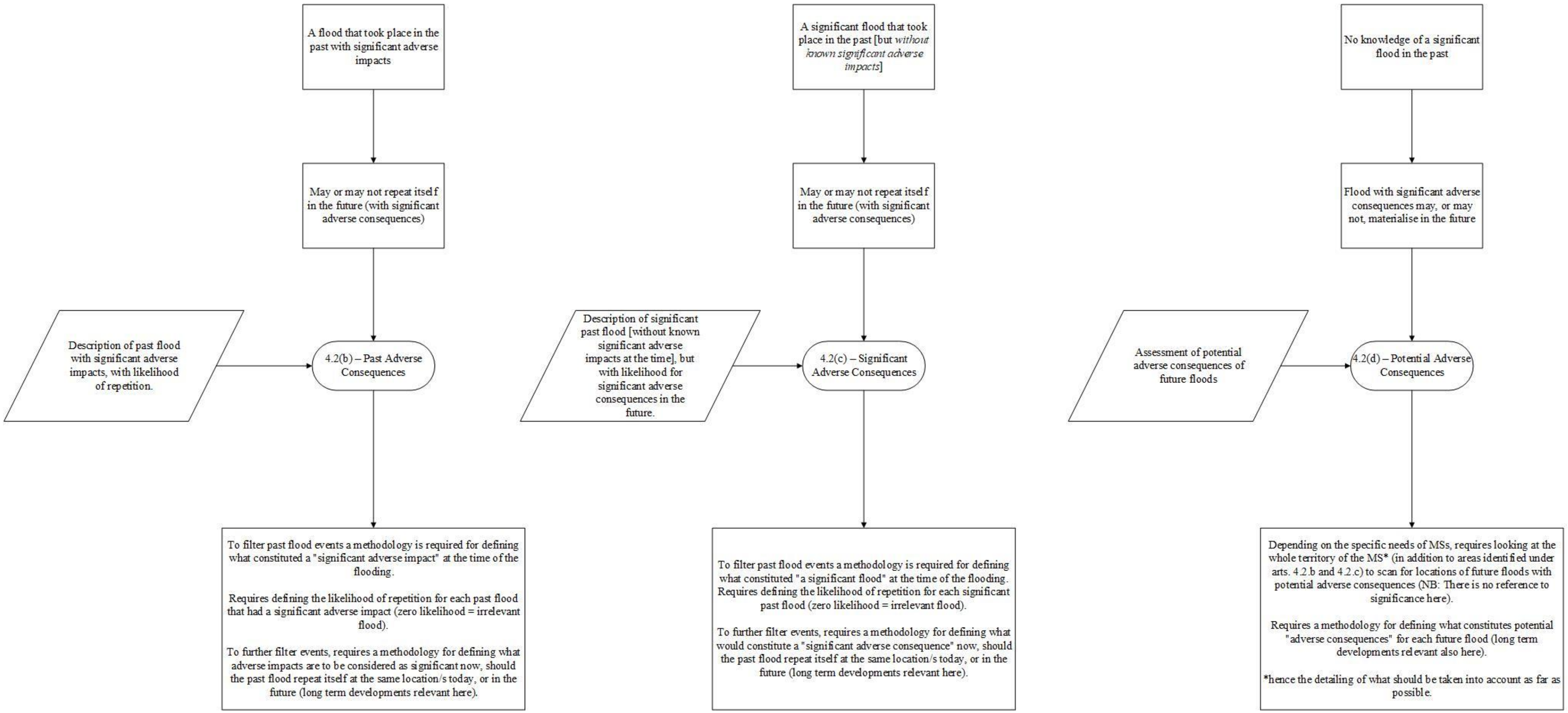
A flood that took place in the past with significant adverse impacts
May or may not repeat itself in the future (with significant adverse consequences)
Description of past flood with significant adverse impacts, with likelihood of repetition.
4.2(b) – Past Adverse Consequences
To filter past flood events a methodology is required for defining what constituted a "significant adverse impact" at the time of the flooding.
Requires defining the likelihood of repetition for each past flood that had a significant adverse impact (zero likelihood = irrelevant flood).
To further filter events, requires a methodology for defining what adverse impacts are to be considered as significant now, should the past flood repeat itself at the same location/s today, or in the future (long term developments relevant here).
A significant flood that took place in the past [but without known significant adverse impacts]
May or may not repeat itself in the future (with significant adverse consequences)
Description of significant past flood [without known significant adverse impacts at the time], but with likelihood for significant adverse consequences in the future.
4.2(c) – Significant Adverse Consequences
To filter past flood events a methodology is required for defining what constituted "a significant flood" at the time of the flooding. Requires defining the likelihood of repetition for each significant past flood (zero likelihood = irrelevant flood).
To further filter events, requires a methodology for defining what would constitute a "significant adverse consequence" now, should the past flood repeat itself at the same location/s today, or in the future (long term developments relevant here).
No knowledge of a significant flood in the past
Flood with significant adverse consequences may, or may not, materialise in the future
Assessment of potential adverse consequences of future floods
4.2(d) – Potential Adverse Consequences
Depending on the specific needs of MSs, requires looking at the whole territory of the MS* (in addition to areas identified under arts. 4.2.b and 4.2.c) to scan for locations of future floods with potential adverse consequences (NB: There is no reference to significance here).
Requires a methodology for defining what constitutes potential "adverse consequences" for each future flood (long term developments relevant also here).
*hence the detailing of what should be taken into account as far as possible.

5.2. Article 4.2(a) – Maps with topography and land use

As stated above, Article 4.2(a) states that the PFRA should include 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.

Figure 3 shows that all the Member States have included maps, or made them available through a map viewer.

Figure 4 shows the number of Member States that have presented strong evidence or some evidence[16] of the required features being included on the maps in their PFRAs and/or any interactive map viewers that had been made available to support the PFRA process. In some cases, the information required was shown on the map viewer, but not in the map published in the PFRA document, or vice versa, which accounts for the "some evidence" being noted. In the case of topography and land use "some evidence" has also been applied where only some elements of topography and land use have been included, or where the information has been included for some UoMs.

Table 3 shows which Member States have included which items in the PFRA. It can clearly be seen that whilst the borders of river basins are largely well represented in the maps, the same cannot be said for the borders of the sub-basins. Most Member States show some topographic and land use information, however, in several cases this could be improved (e.g. use a different scale)[17]. Twelve Member States provided links to specific flood related geoportals that allowed information directly related to the PFRA to be examined interactively[18].

[16] "strong evidence", "some evidence" etc. is an indication of the evidence found during the Commission's assessment of PRFAs and APSFRs, which was based on the information provided by the Member States in EIONET/CDR. The following categorisation was used concerning evidence:

- Strong evidence: clear information provided, describing the approach followed in the PFRA/APSFR phase of the flood risk management cycle to address the criterion.
- Some evidence: reference to the criterion is brief and vague, without a clear indication of the approach followed for the criterion. "some evidence" could also denote "weak evidence".
- No evidence: no information was found to indicate whether a requirement of the FD or an aspect of flood risk management was met or not.
- Evidence to the contrary: an explicit statement was found in the reporting stating that a requirement of the FD or an aspect of flood risk management was not pursued.

[17] See case study 2 at the end of this document.

[18] See case study 3.

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Figure 3: Number of Member States that have included maps in their PFRAs at an appropriate scale

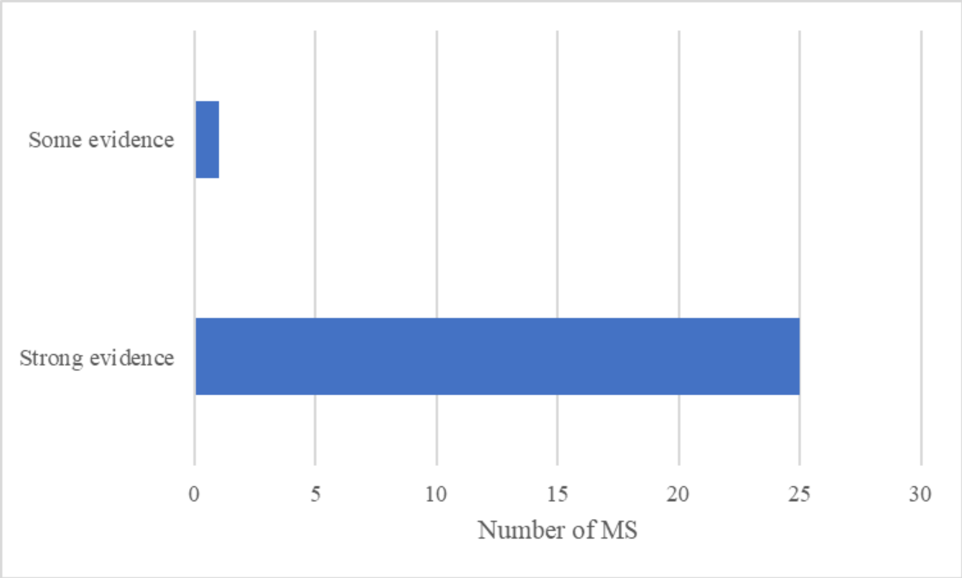
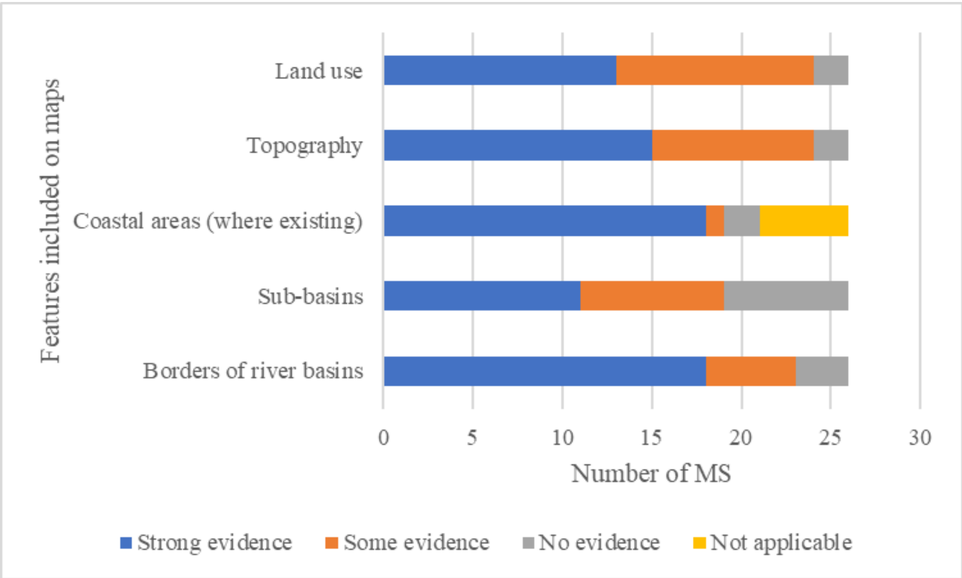


Figure 4: Number of Member States that have included the required map features



Note: five Member States are landlocked (AT, CZ, HU, LU, SK) and therefore the display of coastal areas is not applicable.

Table 3: Information shown on each map by Member States

MS	Maps have been provided	Borders of river basins	Sub-basins	Coastal areas (where existing)	Topography	Land use
AT	Some evidence	Strong evidence	Data not reported	Not applicable	Strong evidence	Data not reported
BE	Strong evidence	Some evidence	Some evidence	Data not reported	Strong evidence	Strong evidence
CY	Strong evidence	Strong evidence	Strong evidence	Strong evidence	Strong evidence	Strong evidence
CZ	Strong evidence	Strong evidence	Strong evidence	Not applicable	Some evidence	Some evidence
DE	Strong evidence	Strong evidence	Some evidence	Strong evidence	Some evidence	Some evidence
DK	Strong evidence	Strong evidence	Data not reported	Strong evidence	Data not reported	Some evidence
EE	Strong evidence	Strong evidence	Strong evidence	Strong evidence	Strong evidence	Strong evidence
EL	Strong evidence	Strong evidence	Data not reported	Strong evidence	Strong evidence	Data not reported
ES	Strong evidence	Strong evidence	Some evidence	Strong evidence	Strong evidence	Some evidence
FI	Strong evidence	Strong evidence	Data not reported	Strong evidence	Strong evidence	Strong evidence
FR	Strong evidence	Strong evidence	Strong evidence	Strong evidence	Some evidence	Some evidence
HR	Strong evidence	Strong evidence	Strong evidence	Strong evidence	Strong evidence	Some evidence
HU	Strong evidence	Strong evidence	Strong evidence	Not applicable	Data not reported	Some evidence
IE	Strong evidence	Data not reported	Data not reported	Strong evidence	Some evidence	Some evidence
IT	Strong evidence	Strong evidence	Some evidence	Some evidence	Some evidence	Some evidence
LT	Strong evidence	Some evidence	Some evidence	Strong evidence	Strong evidence	Strong evidence
LU	Strong evidence	Data not reported	Data not reported	Not applicable	Strong evidence	Strong evidence
LV	Strong evidence	Strong evidence	Data not reported	Data not reported	Strong evidence	Strong evidence
MT	Strong evidence	Strong evidence	Strong evidence	Strong evidence	Strong evidence	Strong evidence
NL	Strong evidence	Some evidence	Some evidence	Strong evidence	Some evidence	Some evidence
PL	Strong evidence	Some evidence	Strong evidence	Strong evidence	Strong evidence	Strong evidence
PT	Strong evidence	Some evidence	Some evidence	Strong evidence	Some evidence	Strong evidence
RO	Strong evidence	Strong evidence	Some evidence	Strong evidence	Some evidence	Strong evidence
SE	Strong evidence	Strong evidence	Strong evidence	Strong evidence	Strong evidence	Strong evidence
SI	Strong evidence	Strong evidence	Strong evidence	Strong evidence	Some evidence	Some evidence
SK	Strong evidence	Strong evidence	Strong evidence	Not applicable	Strong evidence	Strong evidence

Key:

Strong evidence
Some evidence
Not applicable
Data not reported

5.3. Article 4.2(b) – Assessment of past floods with significant impacts

Article 4.2(b) requires Member States to provide a description of past floods with known significant adverse impacts that may reoccur. Reporting requires a methodology for defining what constituted a 'significant adverse impact' at the time of flooding. To achieve this, Member States' CAs need to collect information on the floods that occurred and the impacts that ensued.

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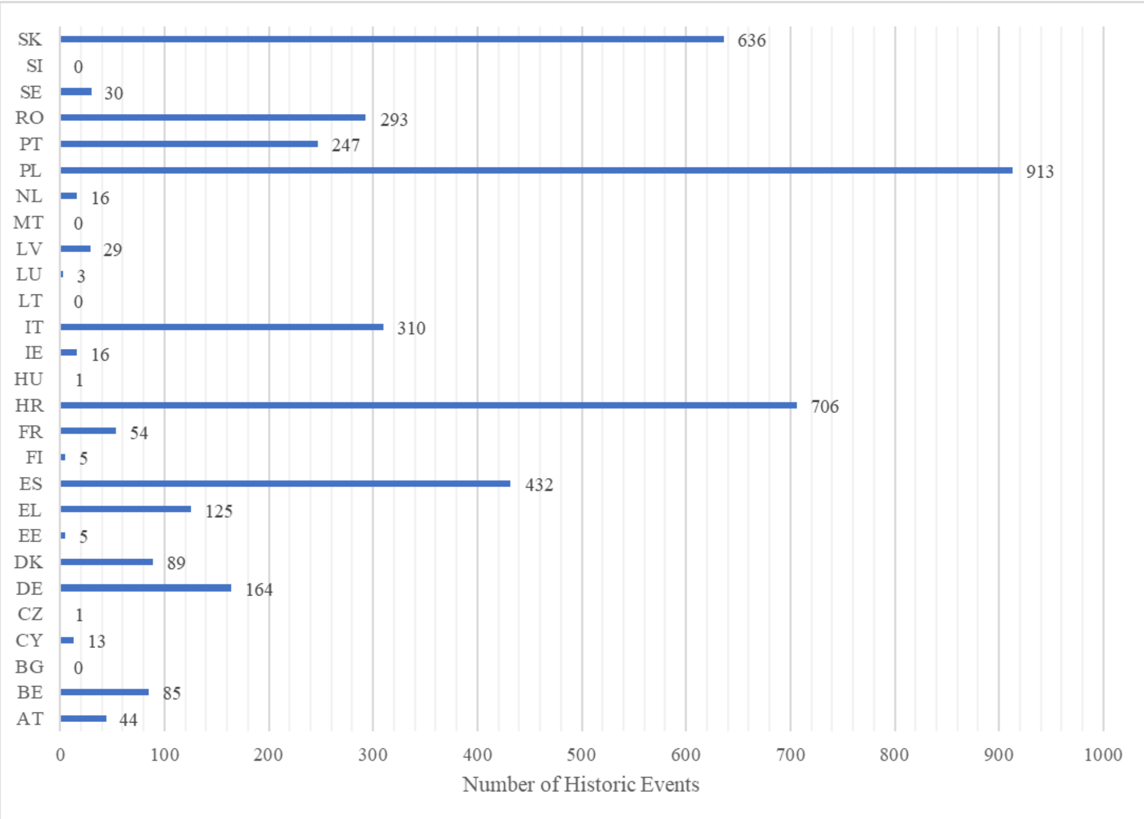
5.3.1. General information on past floods

Figure 5 shows the total number of historic flood events[19] that were included by the Member States in the second cycle reporting exercise, whilst Figure 6 shows the past floods that were reported as having occurred during the period 2012 – 2018 (i.e. during the second cycle); in total around 2 700 flood events. Three Member States[20] did not report any historic flood information to the EIONET CDR. However, in their PFRA reports:

- Lithuania provided information on 17 significant flood events that occurred in the period 2011-2017;
- Malta provided information on eight pluvial foods that had occurred during the second cycle.
- Slovenia provided information on a total of 360 flood events of which 145 occurred after 2010.

Figure 5: Total number of historic flood events (predating 2012 included) as reported to the EIONET CDR in the second cycle by Member States[21]



[19] Some Member States reported flood events dating before 2012, others did not. The "absolute" reporting requirement for the second cycle was to report past floods from 2012 onwards, unless there was a change in previously reported information.

[20] LT, MT and SI.

[21] Data for EL amended as a result of updated information provided by Member States.

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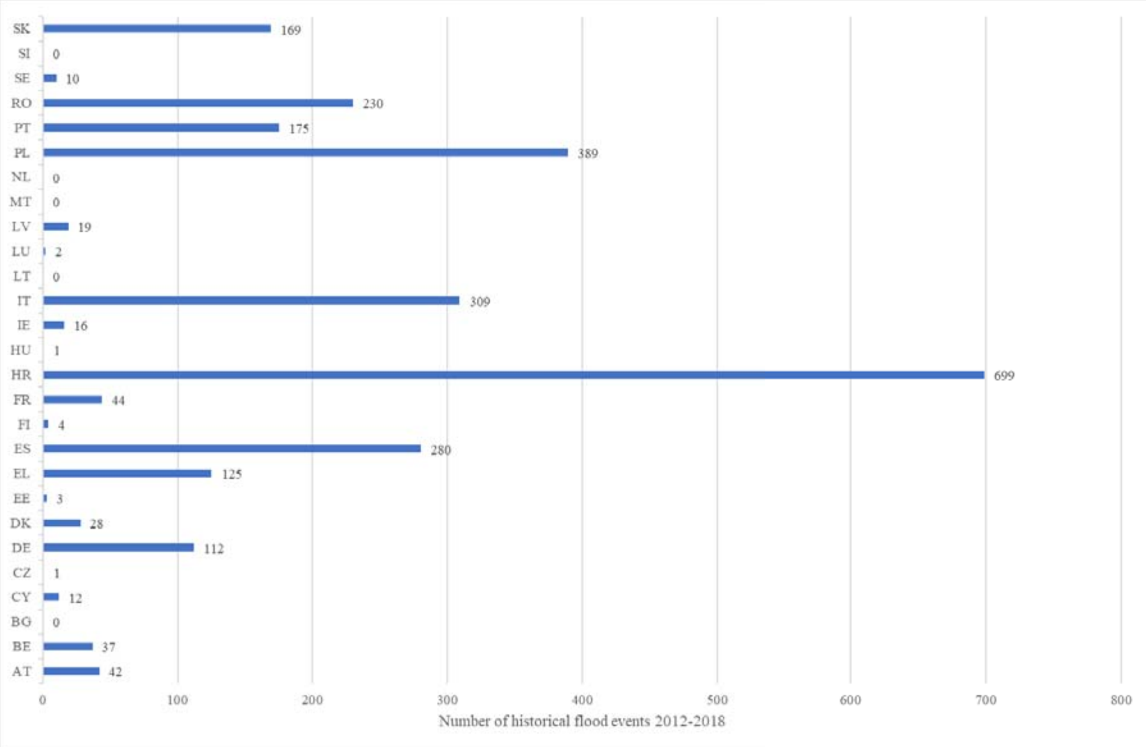
Figure 6: Number of reported flood events that occurred in the period 2012 – 2018 as reported to the EIONET CDR in the second cycle by Member States[22]



Croatia reported the largest number of events (699, slightly over a quarter of the total number of events reported by Member States between 2012 and 2018).

Figure 7 summarises the time periods of the floods reported in the second cycle (floods that occurred during the second cycle, 2012-18, but also before). This shows that half of the floods reported in the second cycle relate to time periods before 2012. The oldest flood event reported (by Poland) in the second cycle was from 1829. Slightly over one third of the flood events reported relate to the period 2000-2010[23].

[22] Data for EL amended as a result of updated information provided by the Member States.

[23] This high proportion of recent floods is to be expected since the reporting requirement for the second cycle was to report past floods from 2012 onwards.

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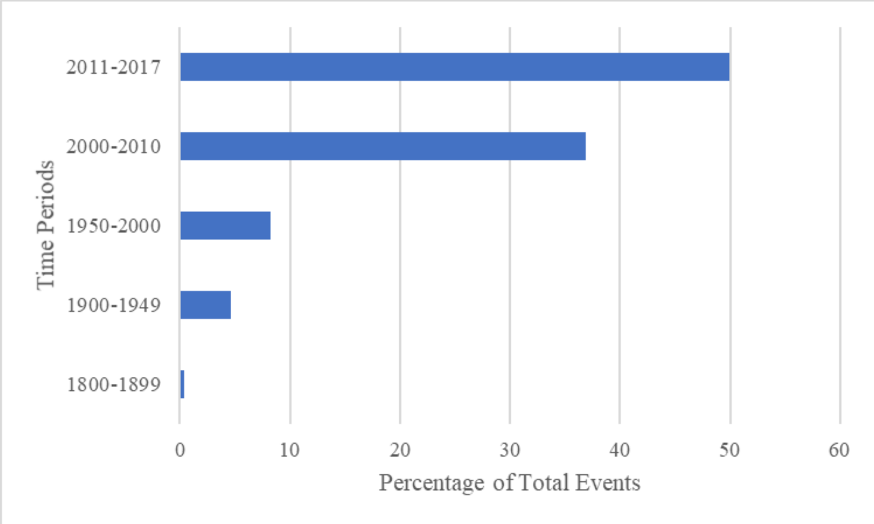
Figure 7: Time periods of flooding as reported to the EIONET CDR in the second cycle



5.3.2. Sources, mechanisms and characteristics of past floods

Figure 8 shows the sources of flooding for the flood events reported that occurred in the period 2012-2018. This shows that for most Member States fluvial flooding remains the most significant source, although for Sweden, pluvial flooding and seawater flooding are reported as the only sources of floods in this period. Czechia, Denmark, Estonia, Greece, Finland, Hungary and Latvia have not reported pluvial flooding as a source of past floods in the period 2012-2018. In addition to Sweden, floods from seawater have been reported by 13 other Member States[24]. Floods from groundwater have been reported by four Member States[25], whilst floods from artificial manmade infrastructure have been reported by six Member States[26].

[24] BE, DK, EE, EL, ES, FI, FR, HR, IE, IT, LV, PL and PT.
[25] FI, HR, PL and SK.
[26] BE, HR, IT, LV, PL, RO.

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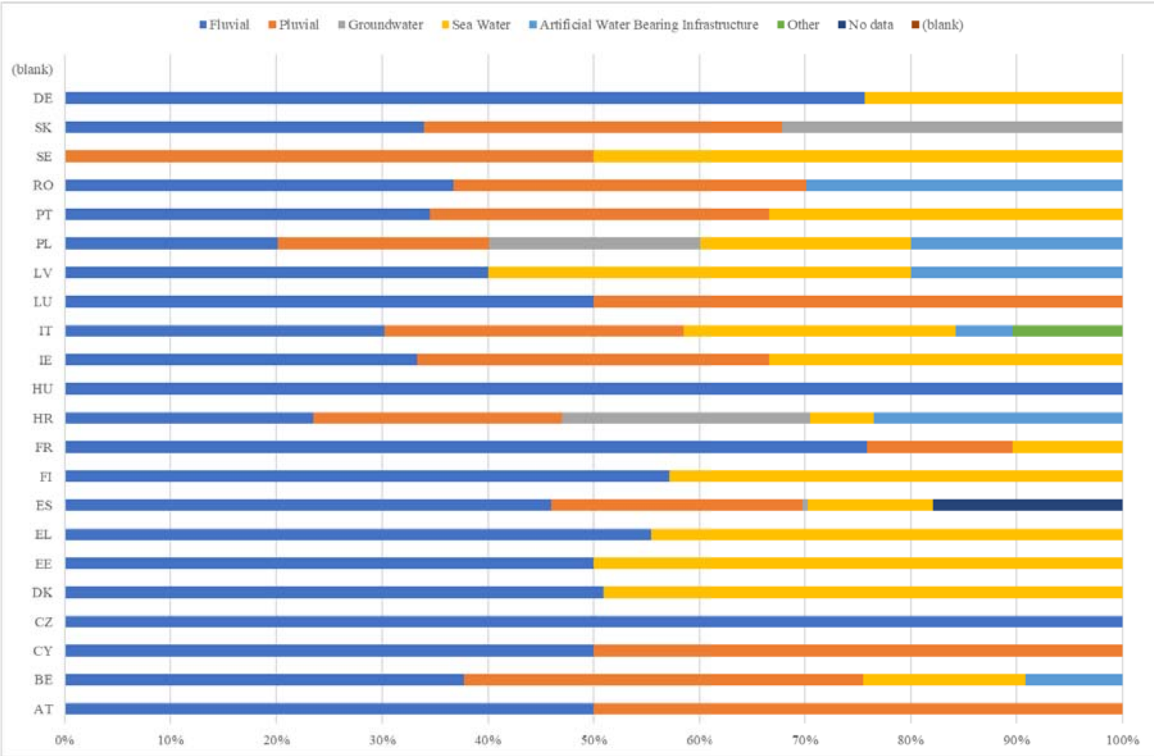
Figure 8: Sources of flooding for the flood events that occurred in the period 2012-2018 as reported to the EIONET CDR in the second cycle by Member States



Notes:

- More than one source of flooding may have been identified for a flood event.
- Bulgaria did not report in time, Lithuania, Malta and Slovenia did not report flood event data.

Figure 9 shows the sources, mechanisms and characteristics[27] of flood events that took place in the period 2012-2018. This shows that at an EU level fluvial flooding is the most significant source (99% of flood events[28]), followed by flooding from seawater (slightly under six for every ten floods) and pluvial flooding (45%). Nearly all floods were generated from natural exceedances (97%) with blockages, defence failures and defence exceedance being other significant causes. The most common characteristics were flash flooding (slightly over two thirds), medium onset flooding (one third), other rapid onset flooding (slightly under three out of every 10) and slow onset flooding (slightly over a quarter). It should be noted that although the source of flooding was reported as "no data" for only 2% of events the mechanism of flooding was reported as no data for slightly over a third of flood events, and the characteristics of flooding were reported as no data for slightly over a quarter of flood events.

[27] See Annex B.

[28] Floods may be attributed to more than one source, mechanism and characteristic.

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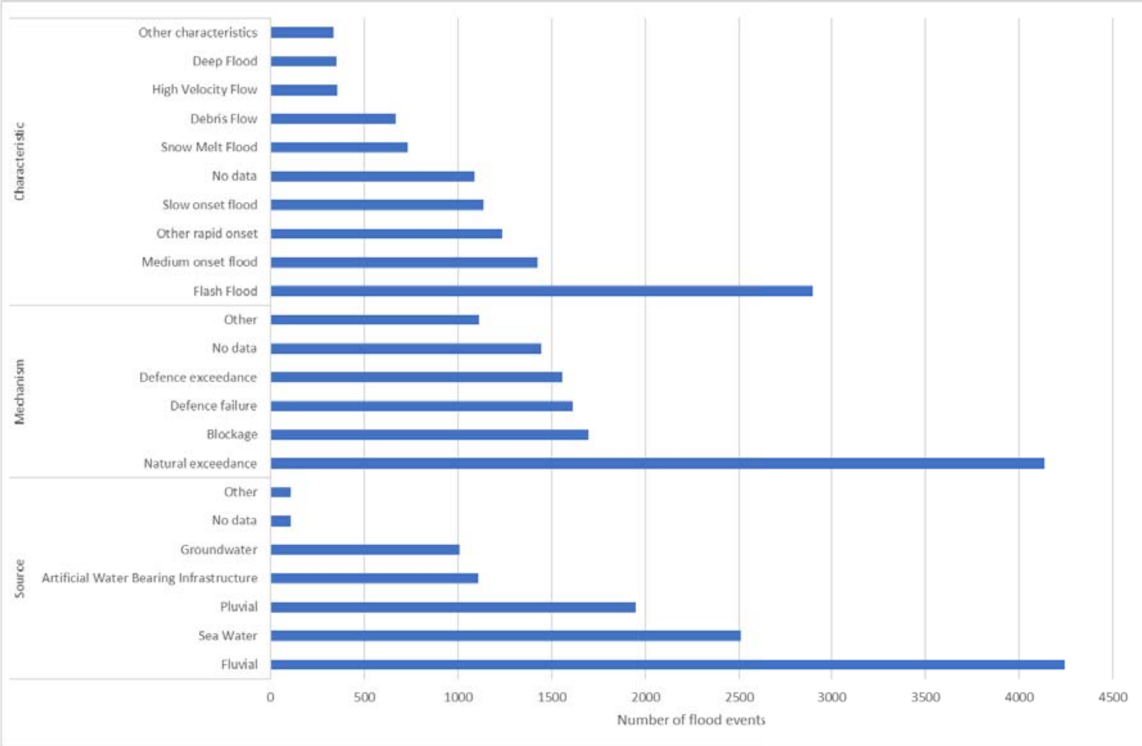
Figure 9: Source, mechanisms and characteristics of flood events occurring in the period 2012-2018 as reported to the EIONET CDR in the second cycle



Note: More than one source, mechanism and characteristic may have been identified for a flood event

5.3.3. Extent and frequency or recurrence of past floods

Some Member States included detailed information in their PFRAs on how they have collected information on past floods. For example, Belgium, the Republic of Ireland and Portugal have developed standardised templates, on-line data collection tools and have drawn on wider information sources such as newspapers[29]. Some Member States have cast the net more widely in respect of the organisations from whom information is collected, for example, Poland supplemented information on the floods that took place before 2012 (so during the first cycle) with new data obtained from various sources including a survey of municipalities, regional authorities, fire brigades and other stakeholders.

The amount and quality of quantitative information reported on the duration, extent and frequency of past floods varies widely between Member States. All Member States that reported past floods reported the date of the flooding. Figure 10 shows the quantitative data reported for date, location, extent, duration, and frequency/recurrence at the event level by Member States.

[29] See case studies 4 - 6 at the end of this document.

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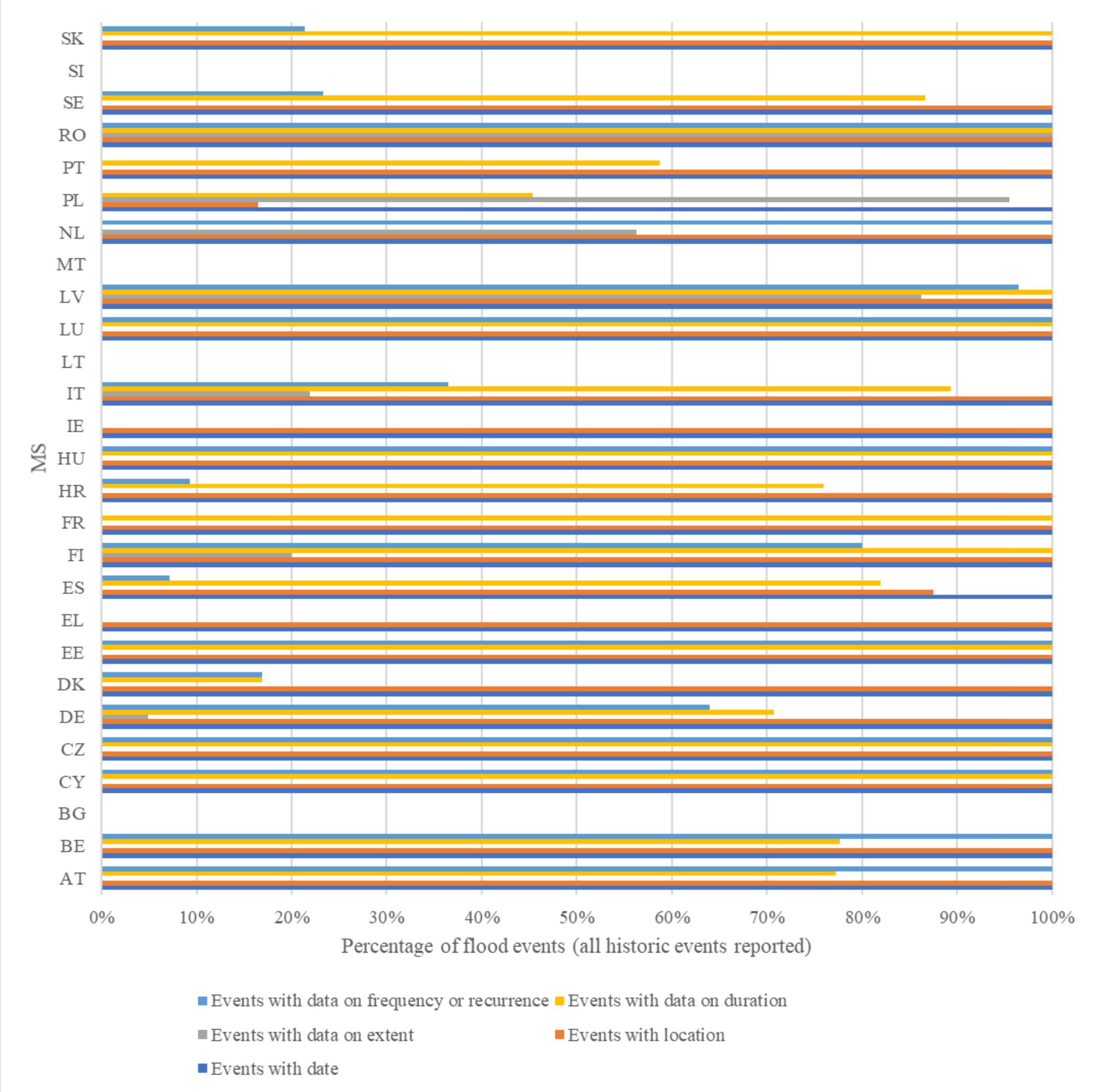
Figure 10: Quantitative data reported to the EIONET CDR in the second cycle on the extent, duration and frequency/recurrence of flood events



Note: Bulgaria did not report, Lithuania, Malta and Slovenia did not report flood event data.

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Table 4 shows the number of UoMs in each Member States for which data on extent, duration and frequency/recurrence was reported.

Table 4: Member States which reported quantitative data on the extent, duration and frequency or recurrence of flood events (for all historic events reported)

MS	Data reported for some or all events on extent of flooding	Data reported some or all events on duration of flood	Data reported some or all events on frequency or recurrence of flooding
AT		1 of 3 UoMs	1 of 3 UoMs
BE		6 of 7 UoMs	
CY			
CZ		1 of 3 UoMs	1 of 3 UoMs
DE	3 of 10 UoMs	7 of 10 UoMs	6 of 10 UoMs
DK		3 of 4 UoMs	3 of 4 UoMs
EE			
EL			
ES		10 of 25 UoMs	8 of 25 UoMs
FI		3 of 8 UoMs	2 of 8 UoMs
FR		13 of 14 UoMs	13 of 14 UoMs
HR			
HU			
IE			
IT	10 of 47	40 of 47 UoMs	31 of 47
LT			
LU		1 of 2 UoMs	1 of 2 UoMs
LV			
MT			
NL			
PL	6 of 9	6 of 9	
PT		10 of 11 UoMs	
RO			
SE		5 of 6 UoMs	5 of 6 UoMs
SI			
SK			

Notes:
AT: Data reported for AT1000 only. No floods occurred in AT2000 or AT5000.
CZ: Data reported for CZ5000 only. No floods occurred in CZ1000 or CZ6000.
DE: Floods reported for 7 UoMs. No floods occurred in DE7000, DE9500, or DE9610.
EE: Data reported for EE1 and EE2. No floods occurred in EE3.
ES: Data reported for 21 UoMs. No floods occurred in ES014, ES150, or ES160.
FI: Data reported for FIVHA3, FIVHA4, FIVHA5. No floods occurred in FIVHA1, FIVHA2, FIVHA6, FIVHA7, or FIWDA.
FR: Data reported for 13 UoMs. No floods occurred in FRB2.
IT: Floods reported for 40 UoMs. No floods occurred in ITI022, ITI029, ITN004, ITR061, ITR151, ITR152, or ITR154.
LU: Floods reported in LU RB_000 only. No floods occurred in LU RB_001.
PL: Floods reported in 6 UoMs. No floods occurred in PL3000, PL4000 or PL8000.

Key:

All UoMs
Some UoMs
Data not reported

All Member States that reported past floods reported the date of flooding for all events, and all but two (Spain and Poland) reported the location for all events. Only Romania

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reported data on the extent, duration and frequency/recurrence for all flood events[30]. Germany and Latvia reported all this information for some events, but not for all. Only six Member States[31] reported some information on the extent of flooding. As stated above, Romania reported the extent of flooding for all events, whilst Poland reported this information for 96% of events and Latvia for 86% of events. Quantitative information on the extent of flooding (either area inundated, or river length flooded) was not reported in nearly eight out of every ten UoMs. Information on the duration of flooding was reported by most Member States with ten Member States[32] reporting duration for all flood events. Of those Member States that reported flood events, three Member States[33] did not report information on the duration of flooding for any events. Nine Member States[34] reported information on the frequency or recurrence of all flood events, but of those Member States that reported flood events four Member States[35] did not report any information. Also the findings of this paragraph point towards increasing the effort of recording information around flood events in order to prepare better responses in the future.

In the first cycle, four Member States[36] applied Article 13.1(b) across all their UoMs and were not required to report information on historic flood events. Other Member States reported flood events with data on type and consequences. At the time the first cycle EU overview document[37] was written, a total of 18 153 historic flood events were reported: 15 660 with data, 2 493 with no data. However, the assessment did not make a distinction between data on the extent, duration and frequency of flooding and data on the impacts of flooding.

The amount of quantitative information reported on the extent, duration and frequency of past events has improved in the second cycle, but there is scope for further improvements in the third cycle of reporting.

5.3.4. Quantitative data on impacts of past floods

In the 2020 national reporting of risk assessments[38] under the Union Civil Protection Mechanism (UCPM)[39], floods were the most commonly identified natural disaster of concern, and floods risk management is therefore an important component of overall disaster risk management. Considering the effects of climate change, it is expected this will continue being the case.

Being in possession of robust disaster loss data improves modelling of disaster risk, the calculation of cost and benefit ratios to ensure effective and transparent investment decisions (including the prioritisation of measures) and helps the public understand the importance of the investments. Also, the assessment of the overall economic damage from disasters underpins the understanding of the macroeconomic impacts of disasters for the purpose of managing public finances, monetary stability and the resilience of financial

[30] See Case Study 7 at the end of this document.
[31] DE, IT, LV, NL, PL and RO.
[32] CY, CZ, EE, FI, FR, HU, LU, LV and SK.
[33] EL, IE and NL.
[34] AT, BE, CY, CZ, EE, HU, LU, NL and RO.
[35] EL, IE, PL and PT.
[36] BE, IT, NL and PT.
[37] https://ec.europa.eu/environment/water/flood_risk/overview.htm
[38] https://op.europa.eu/en/publication-detail/-/publication/89fcf0fc-edb9-11eb-a71c-01aa75ed71a1
[39] https://ec.europa.eu/echo/what/civil-protection/eu-civil-protection-mechanism_en and for UCPM Decision https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32013D1313

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systems[40].

To appreciate the amount of future potential losses, PESETA IV[41] projected that with 3°C global warming, river flood damage in the EU and UK in 2100 would be six times larger than current losses, reaching €48 billion/year. Without mitigation and adaptation measures, annual damage from coastal flooding in the EU and UK could increase sharply from 1.4 €billion nowadays to almost 240 €billion by 2100.

The amended UCPM[42] therefore foresees (Article 6) that "…*MS shall:… (f) in line with international commitments, improve the collection of disaster loss data at national or the appropriate sub-national level to ensure evidence-based scenario building…*"

Further, the EU is party to the UN Sendai Framework for Disaster Risk Reduction, which requires the evaluation of disaster-related losses and economic impacts, and sets a target to reduce such losses by 2030[43]. At EU policy level, climate-related disaster loss data is needed for several policy areas. For example, to improve the economic foundation of adaptation policy and disaster management planning, to increase transparency about climate risks, to inform the European Semester, or to tailor Common Agricultural Policy support for loss recovery and prevention[44].

Thus, there is a need to improve the gathering and access to disaster loss data. As a response to this need, the Risk Data Hub[45] was developed by the Commission and hosted in the Disaster Risk Management Knowledge Centre. The Risk Data Hub is a geoportal offering EU wide harmonized multi-hazard risk and loss data. It is a central repository for recording, sharing and monitoring curated disaster damage and loss data obtained from various open source databases. The new EU Strategy on Adaptation to Climate Change[46] promotes and supports the use of its Risk Data Hub to harmonise the recording and collection of comprehensive and granular climate-related risk and losses data. It also encourages national level public private partnerships to collect and share such data.

The FD introduced in 2007 the requirement for Member States, on the basis of available or readily derivable information, to describe past floods and assess their adverse impacts, and to make an assessment of the potential adverse consequences of future floods. The data on past floods collected via the PFRA process could make a useful contribution to closing loss data gaps. Consequently, Member States were asked, through the updated reporting infrastructure[47], to provide more detailed information, where available, on the costs of damage resulting from historic flood events as:

- The total cost of damage in €;
- The total cost of damage as a proportion of GDP; or

[40] See also https://ec.europa.eu/echo/what/civil-protection/european-disaster-risk-management/economics-disaster-prevention-and-preparedness_en
[41] https://ec.europa.eu/jrc/en/peseta-iv
[42] Decision No 1313/2013/EU on a Union Civil Protection Mechanism as amended by Regulation (EU) 2021/836 of the European Parliament and of the Council of 20 May 2021, https://eur-lex.europa.eu/eli/reg/2021/836/oj
[43] https://www.eea.europa.eu/ims/economic-losses-from-climate-related
[44] Closing the climate protection gap - Scoping policy and data gaps, European Commission, SWD(2021) 123 final https://ec.europa.eu/clima/system/files/2021-06/swd_2021_123_en.pdf
[45] https://drmkc.jrc.ec.europa.eu/risk-data-hub#/
[46] https://ec.europa.eu/clima/eu-action/adaptation-climate-change/eu-adaptation-strategy_en
[47] https://cdr.eionet.europa.eu/help/Floods/Floods_2018/index.html

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- A qualitative assessment as a damage class:
  - I - Insignificant
  - L - Low
  - M - Medium
  - H - High
  - VH - Very high (VH)
  - NA – Not Applicable; or
  - U – Unknown.

Figure 11 shows the types of impact information that was provided at flood event level by Member States. Of those Member States who reported event data, nine[48] did not report a qualitative or quantitative assessment of the level of impact of flood events, although the four broad types of impact as required by the FD (economy, health, cultural heritage, environment) were identified.

[48] CZ, DE, EE, FR, HR, IE, PT, RO and SE.

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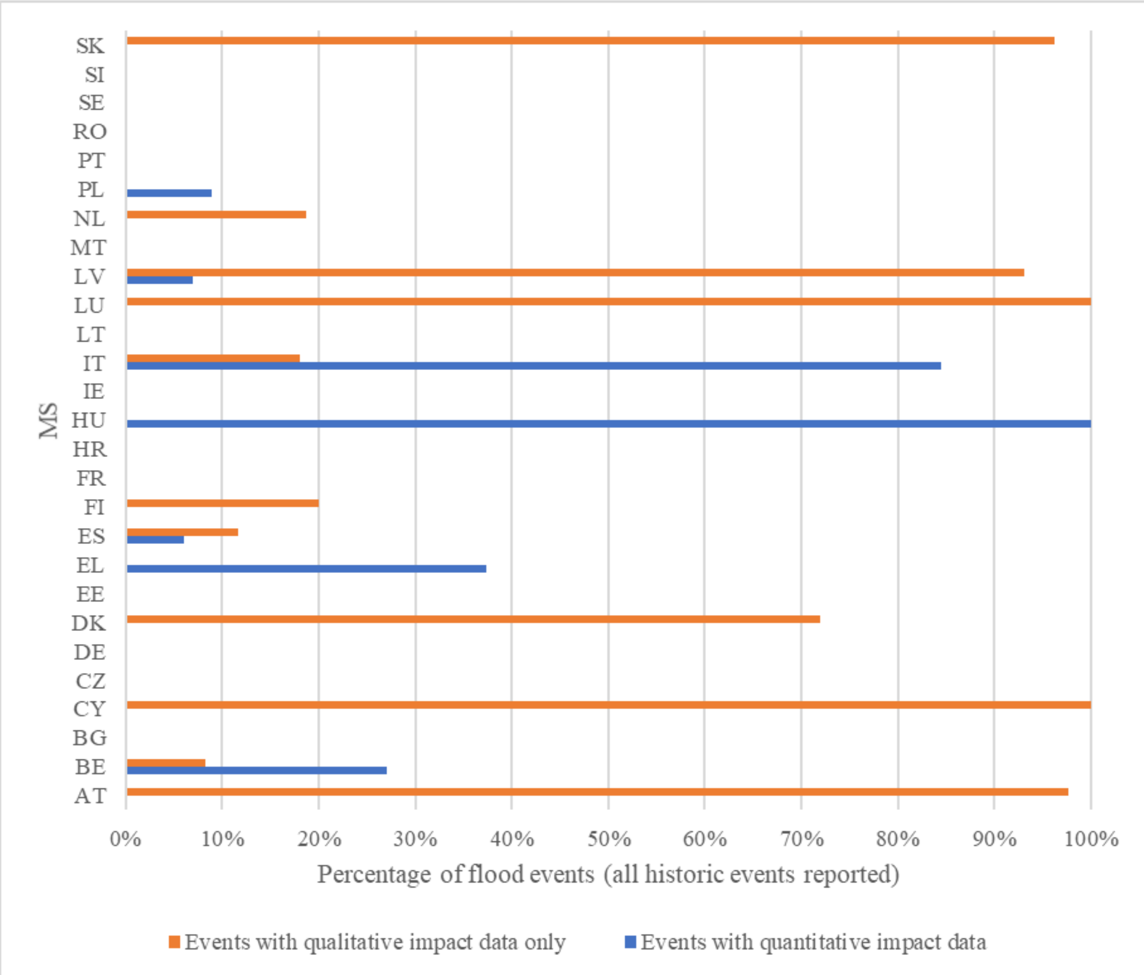
Figure 11 Data reported on the impact of flood events at event level as reported to the EIONET CDR in the second cycle by Member States for all historic floods reported[49]

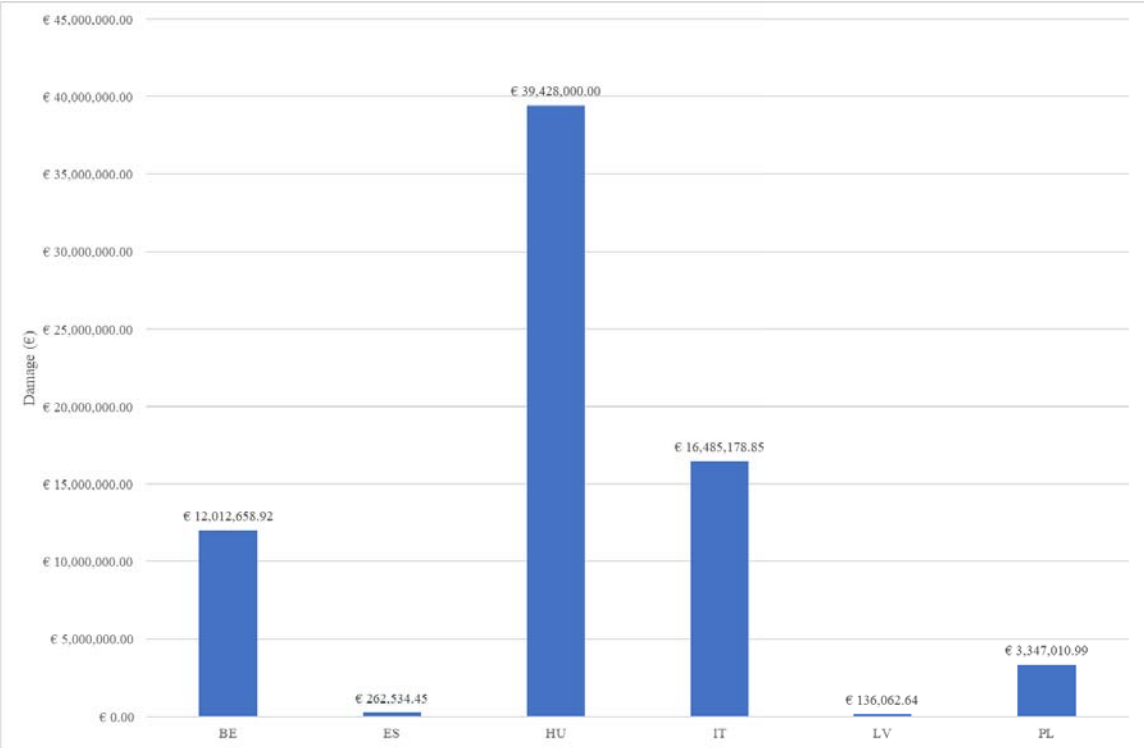


Notes:
- Bulgaria did not report, Lithuania, Malta and Slovenia did not report flood event data.
- Although it appears Hungary provided quantitative data on the impact of all flood events reported, it should be noted that Hungary only reported one event in the second cycle.

Six other Member States[50] reported quantitative data totalling €3 778 527 772 for historic floods (over the years 2012-18), with Italy doing so for 85% of a total of 310 flood events. The average level of damage per event for these six Member States is shown in Figure 12.

[49]Member States were asked to quantify the consequences of flooding to human health, environment, cultural heritage and economic activity
[50] BE, EL, ES, LV, IT and PL.

Figure 12: Average damage per flood event for events where damage was reported as reported to the EIONET CDR in the second cycle



Note: Greece also provided data on the damage by event, but the data extracted from the CDR appeared to be erroneous.

Eleven Member States[51] provided a qualitative assessment of the impact of flood events, with Cyprus and Luxembourg doing so for all flood events, and Austria doing so for 98% of events.

The data reported on the impact of past floods in the first cycle is described in the section on duration, extent and frequency of flooding above. The amount of quantitative information reported on the impact of past events has improved in the second cycle, but there is scope for further improvements in the third cycle of reporting.

In addition to the data reported to the EIONET CDR on extent, duration, recurrence and impact of flooding, there is often more detail presented in the PFRA reports or in other documents. For example, Austria provided a file containing detailed information on each of the 45 significant floods that have occurred since 2011. The information collected includes the date and location of each flood, the duration, frequency, origin, cause and mechanisms of each flood and the damage caused in terms of the area, inhabitants affected and total damage costs. Information is also included on the cost of damage prevention in the future as a total cost per event ranging from €20k-€5 million (total cost €5.9 million), and the costs incurred to repair damage per event by one of the two Federal Agencies responsible, the Federal Hydraulic Engineering Administration[52] (cost ranged from €2 - €5.5 million and totalled in excess of €18.25 million). The spreadsheet allows for collection

[51] AT, BE, CY, DK, ES, FI, IT, LU, LV, NL and SK.
[52] Bundeswasserbauverwaltung.

of data from the other Federal Agency with responsibility, the Torrent and Avalanche Control[53], but no data has currently been included.

Hungary, who reported only one significant flood in the second cycle PFRA, provided a detailed textual description in the PFRA document[54], in addition to providing qualitative and quantitative information (economic damage) in the report to the EIONET CDR[55].

5.3.5. Methodologies and criteria used for the assessment of the significance of the impacts of past floods

Article 4.2(b) of the FD requires Member States to identify the adverse impacts on human health, the environment, cultural heritage and economic activity of past floods 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.

Figure 13 shows the criteria used in UoMs to assess the impact of past floods, and Table 5 shows the criteria used in the UoMs in each Member State. The most used criteria[56] are:

- Return period (nearly two thirds of UoMs)
- Flooded area (slightly over six for every 10 UoMs);
- Residents affected (exactly six out of every 10 UoMs);
- Commercial area affected (57% of UoMs); and
- Buildings affected (54% of UoMs).

A number of UoMs (28%) used other criteria. Examples of these include the number of fatalities caused by flooding, trams being blocked for several days and ecological damage due to pollution of a protected area (Austria), the number of “memorable” events and the number of fatalities (France), the declaration of emergency by the state and/or fatalities due to floods (Greece) and the number of evacuations (the Netherlands). Expert judgement was used by 17% of UoMs. Examples of how this was applied include:

- The use of local knowledge and field expertise to identify the floods with the most significant impacts (Belgium/Wallonia).

- The historical storm surges are assessed and described with five categories: Water Level, Meteorology, Flood, Damage and Human Consequences. For each category, the parameters Data Availability, Data Quality and Phenomenon were assessed on a scale from 0 to 3. Under these, the categories Injuries and People represent the consequences of the flood, where the parameter Phenomenon describes the extent. If the phenomenon of an incident is 2 or greater, the flood is defined as having extensive damage (Denmark).

- Assessment of impacts conducted by gathering all of the available data and reviewing it by experts on case to case basis (Lithuania).

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53 Wildbach- und Lawinenverbauung.

54 See case study 8 at the end of this document.

55 In the case of Hungary a series of cascading floods has been reported as one event. Most Member Stateshave chosen to report cascading floods as a number of distinct events.

56 An example of how these criteria have been used is provided in Case Study 9 (for Czechia) at the end of this document.

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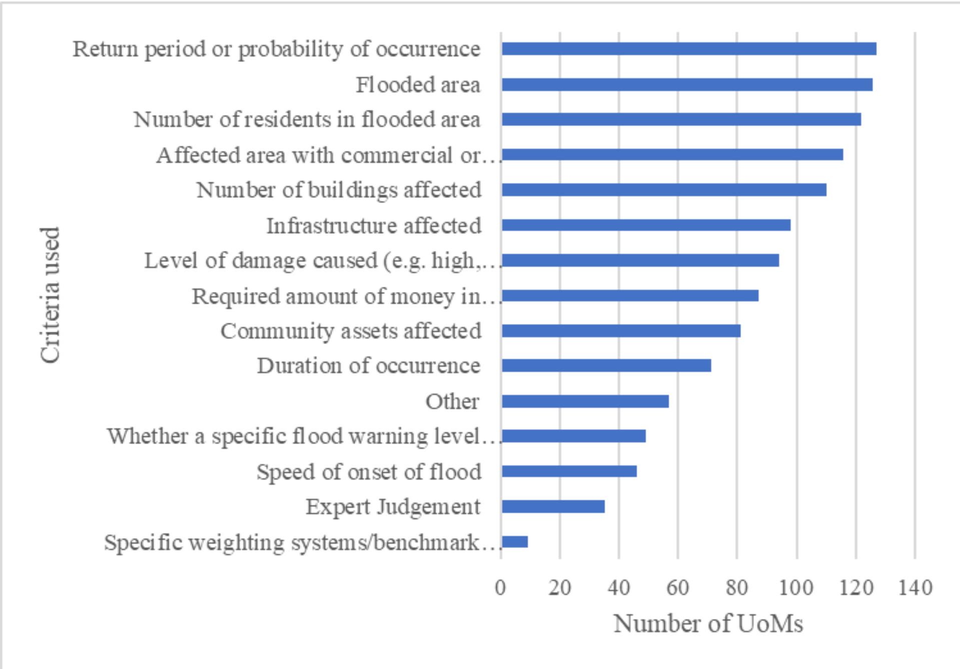
- Definition of areas where floods with significant adverse impacts may reoccur based on size and location of the sub-catchment, predominant land use of the sub-catchment, runoff volume generated at the basin outlet of the sub-catchment, documented flood events in the past within the sub-catchment (Malta).

- Data on historical floods obtained and updated mainly by competent units as a result of a survey of municipalities, communes, provinces, crisis management centers, provincial fire brigade units, irrigation and water authorities (Poland).

Figure 13: Criteria used by UoMs for the assessment of the impact of past floods as reported to the EIONET CDR in the second cycle



Note: More than one criteria can be used to assess the impact of past floods.

Table 5: Criteria used in each Member States to assess the impact of past floods according to Article 4.2(b)

MS	Specific weighting systems/benchmark defined to assess significance	Expert Judgement	Speed of onset of flood	Whether a specific flood warning level was triggered	Other	Duration of occurrence	Community assets affected	Required amount of money in compensation	Level of damage caused (e.g. high, medium, low)	Infrastructure affected	Number of buildings affected	Affected area with commercial or industrial use	Number of residents in flooded area	Flooded area	Return period or probability of occurrence
AT															
BE		4 of 7						2 of 7			3 of 7			4 of 7	
CY															
CZ															
DE															
DK															
EE															
EL															
ES	3 of 25			1 of 25	3 of 25	2 of 25	7 of 25	15 of 25	17 of 25	15 of 25	14 of 25	11 of 25	16 of 25	15 of 25	4 of 25
FI		7 of 8	7 of 8		7 of 8		7 of 8			7 of 8	7 of 8	7 of 8	7 of 8		
FR				2 of 14									3 of 14	1 of 14	
HR															
HU															
IE															
IT	1 of 47		33 of 47	26 of 47		38 of 47		38 of 47	38 of 47		42 of 47				
LT															
LU															
LV															
MT															

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MS	Specific weighting systems/benchmark defined to assess significance	Expert Judgement	Speed of onset of flood	Whether a specific flood warning level was triggered	Other	Duration of occurrence	Community assets affected	Required amount of money in compensation	Level of damage caused (e.g. high, medium, low)	Infrastructure affected	Number of buildings affected	Affected area with commercial or industrial use	Number of residents in flooded area	Flooded area	Return period or probability of occurrence
NL															
PL		7 of 9			7 of 9										
PT						9 of 11	1 of 11		10 of 11	2 of 11	1 of 11			1 of 11	
RO															
SE															
SI															
SK	1 of 2			1 of 2											1 of 2

Key:

Criteria used in all UoMs
Criteria used in some UoMs
Criteria not known to have been used in any UoMs

Figure 14 shows the number of Member States where the results of the individual Member States assessments show that there is strong, some or no evidence of a clear methodology being in place for the assessment of past floods. This shows that almost two thirds of the Member States have presented strong evidence to show that a clear methodology is in place for the assessment of past floods[57]. Two Member States (Malta and Slovakia) presented no evidence in the reported information.

Figure 14: The number of Member States where there is strong, some, or no evidence of a clear methodology being in place for the defining past floods with significant adverse impacts as required by Article 4.2(b)

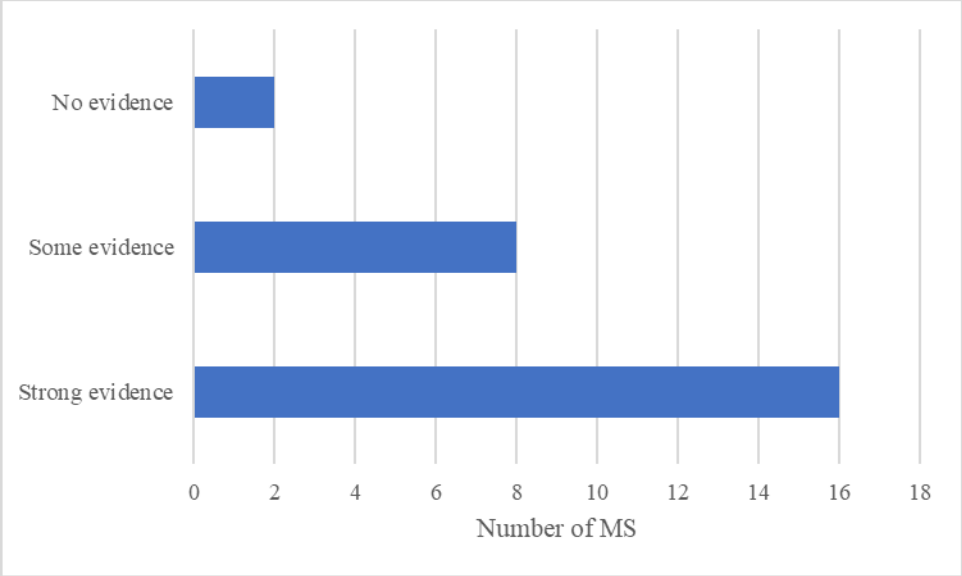

Figure 15 shows the percentage of UoMs (as a proportion of the total of 206 UoMs in the EU) that indicated impacts of past flood events in the second cycle PFRAs. The greatest number of UoMs (nearly four fifhts) reported economic impacts on infrastructure as a result of flooding and slightly over two thirds reported economic impacts on property. Impacts on human health as a result of flood events were reported by 56% of UoMs, and impact on the health and social well-being of communities reported by slightly under half of UoMs. The impact of flooding on cultural heritage has been accounted for with 46% of the UoMs reporting impacts of flood events on cultural assets but the impact of flooding on the environment appears to be less prevalent with a bit over a quarter of UoMs reporting impacts to protected areas, just under a quarter reporting impacts to water bodies and a bit less than a quarter reporting impacts on pollution sources.

[57] AT, BE, CY, CZ, DE, EE, FI, FR, HU, IE, IT, LV, NL, RO, SE and SI.

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Figure 15: Percentage of UoMs that have reported impacts of past floods to the EIONET CDR in the second cycle

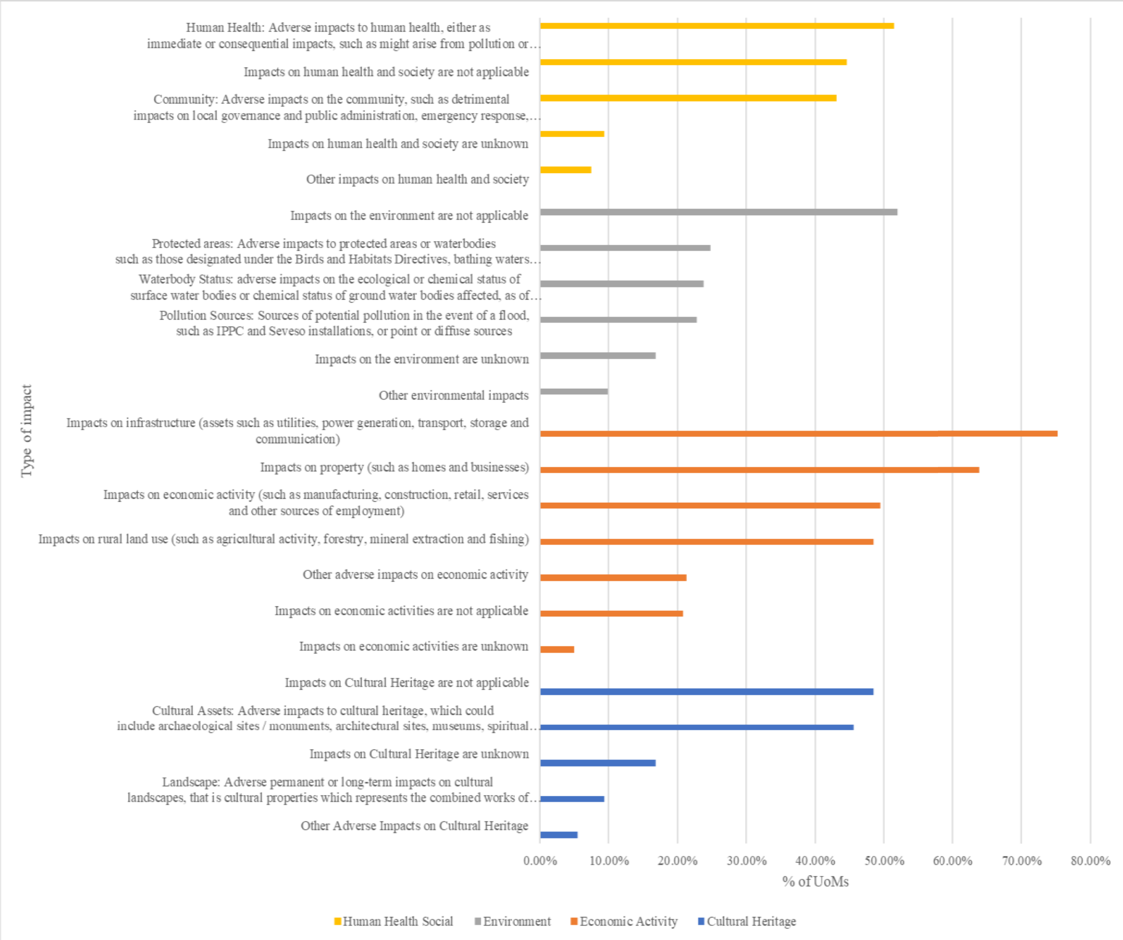

Figure 16 presents the impact reported for flood locations for events that occurred only in the period 2012-2018. "Not applicable" was reported as the most significant impact for impacts on human health (84%), the environment and cultural heritage (each 82%). However, impacts on infrastructure (assets such as utilities, power generation, transport, storage and communication) were reported in 43% of locations, on property (such as homes and businesses) in 29% of locations and on economic activity (such as manufacturing, construction, retail, services and other sources of employment) in 12% of locations. Other economic impacts were reported in 28% of locations, these included:

- Economic activity which is significant in terms of ensuring the functions vital to society (Finland);
- Hydraulic works-longitudinal defence works such as embankments, bank walls, groynes (Italy).

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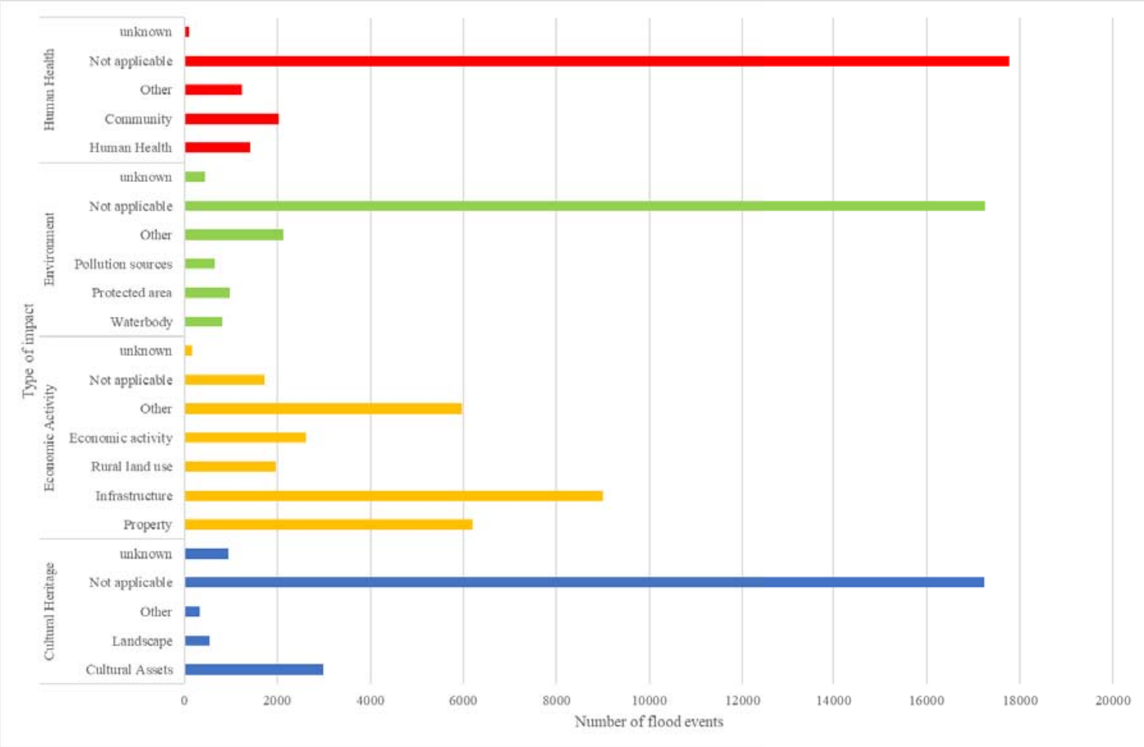
Figure 16: Number of flood locations[58] in the period 2012 – 2018 that have been identified as having been impacted as reported to the EIONET CDR in the second cycle



Many of the UoMs use quantitative data to evaluate the significance of the impact of past floods. For example, in the Netherlands[59], the impact on populations and the cost of the damage incurred is assessed, whilst in Latvia[60] the focus is on the expenditure that has been required to make good the damage. In Belgium (Flanders), the assessment of past floods is based on data from the disaster fund and the insurance sector.

The complexity of the methodology used to identify significant past floods varies widely between Member States. Some use a simple methodology, for example Slovenia[61] identified past floods as significant if: (1) there were fatalities; (2) there was damage to people's property; (3) there was damage to infrastructure including cultural heritage. Others, such as Portugal, applied a classification scheme based on the damage to a number of receptors which were combined to give an overall classification[62].

The two attributes that are singled out for consideration in the assessment of significance of impact according to Article 4.2 (b) are:

- The extent of past flooding; and
- Conveyance routes.

Figure 17 presents the number of Member States where the results of the Commission's individual Member State assessments show that there is strong, some or no evidence of

[58] One flood event may impact one or more flood locations.
[59] See Case Study 10 at the end of this document.
[60] See Case Study 11.
[61] See Case Study 12.
[62] See Case Study 13.

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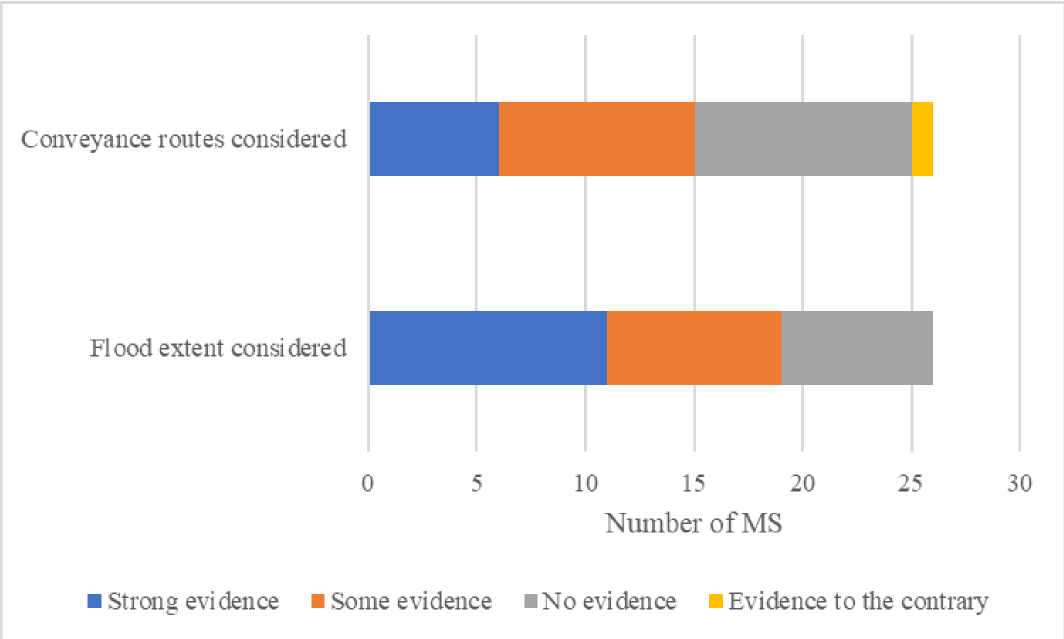
either the extent of past flooding and conveyance routes being taken into consideration in the assessment of impact of past floods.

For 11 Member States[63] there is strong evidence that the extent of flooding has been considered, with some evidence presented for a further eight Member States[64]. For example, in Denmark, extent of flooding is classified on a scale of 0, 1, 2 or 3 depending on data availability and quality[65]. Italy has developed a database (FloodCat) and a data entry platform (Heroic) which enables information on flood events, including spatial data on the extent of flooding, to be captured and used for the assessment of past floods as required by both Article 4.2(b) and 4.2(c).[66]

However, according to the reported information, only six Member States[67] presented strong evidence of having considered conveyance routes in the assessment of past floods. Luxembourg provided a detailed assessment of a flood that occurred in January 2011 which included the use of satellite imagery to map the conveyance route of flood which will contribute to the refinement of models in the future[68]. A further nine[69] Member States presented some evidence of having done so. Some Member States noted that consideration of conveyance routes is an implicit part of the PFRA (e.g. Austria) or is part of flood hazard modelling and mapping (e.g. Sweden).

Figure 17: Number of Member States that have provided evidence that demonstrates whether the extent of past flooding and conveyance routes have been considered in the assessment of past floods according to Article 4.2(b)[70]



[63] BE, CZ, DK, HR, HU, IE, IT, LU, NL, RO and SI.
[64] AT, EE, FI, LT, LV, MT, PL and SE.
[65] See case study 14.
[66] The database has also been developed to be consistent with the Commission's reporting guidance for the FD to allow the data to be easily exported and uploaded to the EIONET CDR.
[67] BE, CZ, HU, IE, LU and RO.
[68] See case study 15.
[69] CY, EE, HR, IT, LT, LV, MT, PL and SE.
[70] Evidence to the contrary: An explicit statement was found in the reporting stating that this criterion was not pursued.

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5.4. Article 4.2(c) – Assessment of past floods without known significant impacts that may have significant impacts if repeated in the future

5.4.1. Methodologies and criteria used for the assessment of significant past floods without known impacts

Article 4.2(c) requires Member States to include a description of the significant floods (in terms of extent) which have occurred in the past (without significant impacts however), where significant adverse consequences of similar future events might be envisaged due to climate and/or socio-economic change.

Figure 18 shows the number of Member States where strong evidence, some evidence or no evidence was found of a clear and distinct methodology being in place for the implementation of Article 4.2(c). Only seven Member States[71] were found to have provided strong evidence of a clear and distinct methodology being in place for the assessment of such floods whilst 12 Member States[72] presented some evidence. In most of these cases there was evidence that this had been considered, but the methodology was not presented in a clear way, or there was no distinction between the methodologies applied in relation to Article 4.2(b) or Article 4.2(d). The remaining Member States presented no evidence that Article 4.2(c) had been addressed. In most cases no reasons were provided for this, but Poland did state that Article 4.2(c) had not been applied due to a lack of data.

Figure 18: Number of Member States where there is strong, some or no evidence of a clear methodology being in place for the assessment under Article 4.2(c)

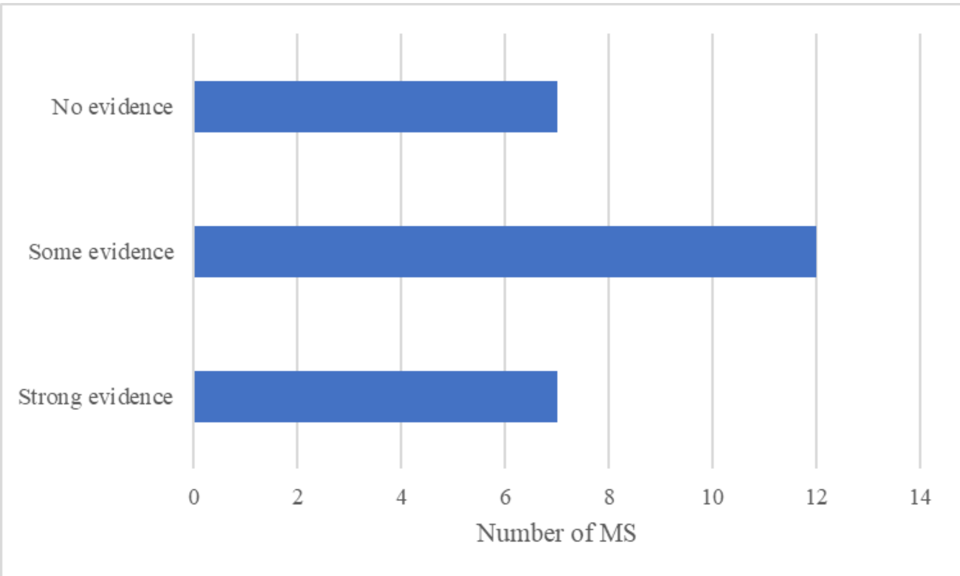
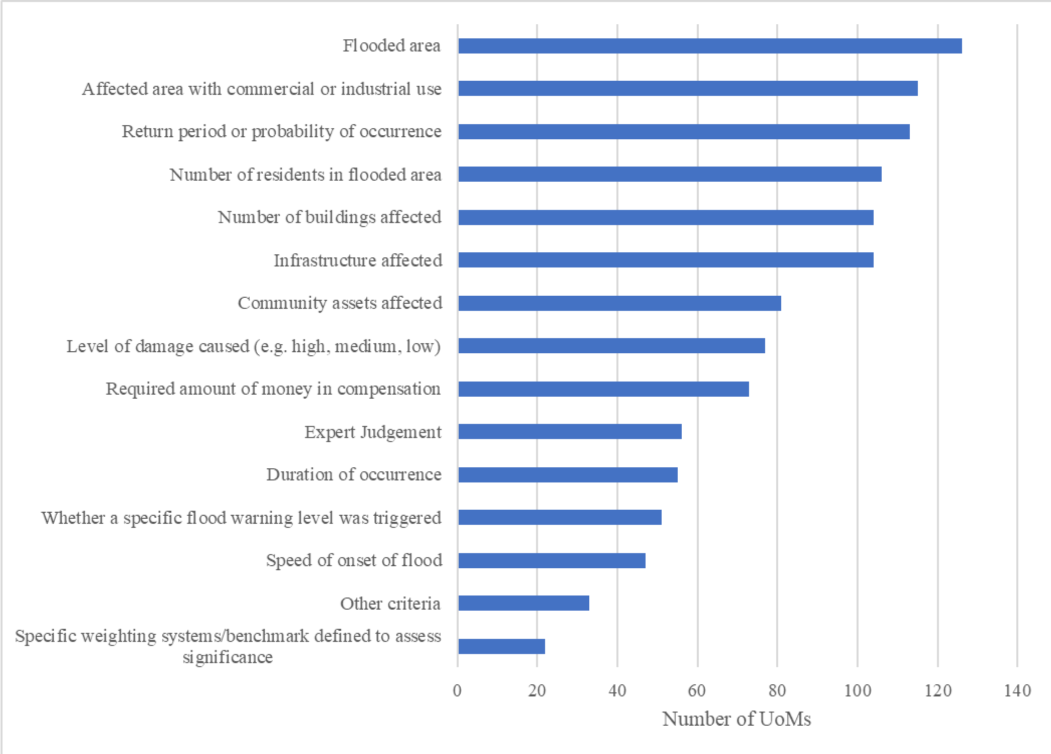


Figure 19 shows the criteria used by UoMs to define significant past floods (without impacts at the time) which may have an impact in the future as reported by Member States to the EIONET CDR.

[71] BE, DE, DK, HR, IE, NL and RO.
[72] AT, CY, CZ, EE, ES, FI, HU, LT, LU, PT, SI and SK.

Figure 19: Criteria for defining the significance of past floods without known significant adverse impacts under Article 4.2(c) as reported to the EIONET CDR in the second cycle.



Note: More than one criteria can be applied for the assessment of past floods.

Table 6 shows which of these criteria were selected by which Member States. The most frequently used criteria were flooded area and return period (slightly under two thirds of UoMs each), buildings affected (also a bit under two thirds of UoMs), residents affected, and commercial area affected (61% of UoMs each). Weighting systems were used by only 14% of UoMs. Slightly less than a fifth of UoMs reported that other criteria were used, these included (similar to Article 4.2(b)):

- Number of fatalities caused by flooding, trams being blocked for several days, ecological damage due to pollution of a protected area (Austria);
- Harmful consequence for the environment and cultural heritage (Finland);
- Number of deaths and "memorable" events (France);
- Indication of frequency, number of evacuations and date of occurrence, after 1900 (the Netherlands).

Expert judgement was used in 28% of UoMs, mostly in conjunction with other criteria. Examples of how this was applied include:

- Definition of areas where significant past floods without known significant adverse impacts but where significant adverse consequences might be envisaged based on size and location of the sub-catchment, predominant land use of the sub-catchment, runoff volume generated at the basin outlet of the sub-catchment, documented flood events in the past within the sub-catchment (Malta).

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- The likely impact that would occur should urban development occur in areas that have flooded in the past with no impact (Sweden).

Only Croatia used expert judgement alone. Four floods were identified for further assessment but the exact methodology used is not clear.

In the first cycle's EU overview document no distinction was drawn between the methodology for Articles 4.2(b) and 4.2(c). Although in the second cycle this has become clearer, it is not possible to compare and determine whether the situation with respect to discerning between Articles 4.2(b) and 4.2(c) has improved in the second cycle. Member States should consider providing clearer information on how Article 4.2(c) has been applied. A comparison will be possible in the third cycle.

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Table 6: Criteria used by each Member States for defining past floods without known significant adverse impacts under Article 4.2(c)

MS	Specific weighting systems/benchmark defined to assess significance	Other criteria	Speed of onset of flood	Whether a specific flood warning level was triggered	Duration of occurrence	Expert Judgement	Required amount of money in compensation	Level of damage caused (e.g. high, medium, low)	Community assets affected	Infrastructure affected	Number of buildings affected	Number of residents in flooded area	Return period or probability of occurrence	Affected area with commercial or industrial use	Flooded area
AT															
BE				1 of 7		4 of 7					1 of 7		3 of 7		
BG	No data reported														
CY															
CZ															
DE															
DK															
EE															
EL															
ES	2 of 25			1 of 25		10 of 25	6 of 25	14 of 25	7 of 25	14 of 25	16 of 25	15 of 25		11 of 25	14 of 25
FI		7 of 8	7 of 8			7 of 8			7 of 8	7 of 8	7 of 8	7 of 8		7 of 8	
FR				2 of 14								3 of 14			
HR															
HU															
IE															
IT	1 of 47		33 of 47	26 of 47	38 of 47		38 of 47	38 of 47			42 of 47				
LT															
LU															
LV															

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MS	Specific weighting systems/benchmark defined to assess significance	Other criteria	Speed of onset of flood	Whether a specific flood warning level was triggered	Duration of occurrence	Expert Judgement	Required amount of money in compensation	Level of damage caused (e.g. high, medium, low)	Community assets affected	Infrastructure affected	Number of buildings affected	Number of residents in flooded area	Return period or probability of occurrence	Affected area with commercial or industrial use	Flooded area
MT															
NL															
PL		7 of 9													
PT									1 of 11						10 of 11
RO															
SE															
SI															
SK				1 of 2											

Key:

Criteria used in all UoMs
Criteria used in some UoMs
Criteria not known to have been applied in any UoMs

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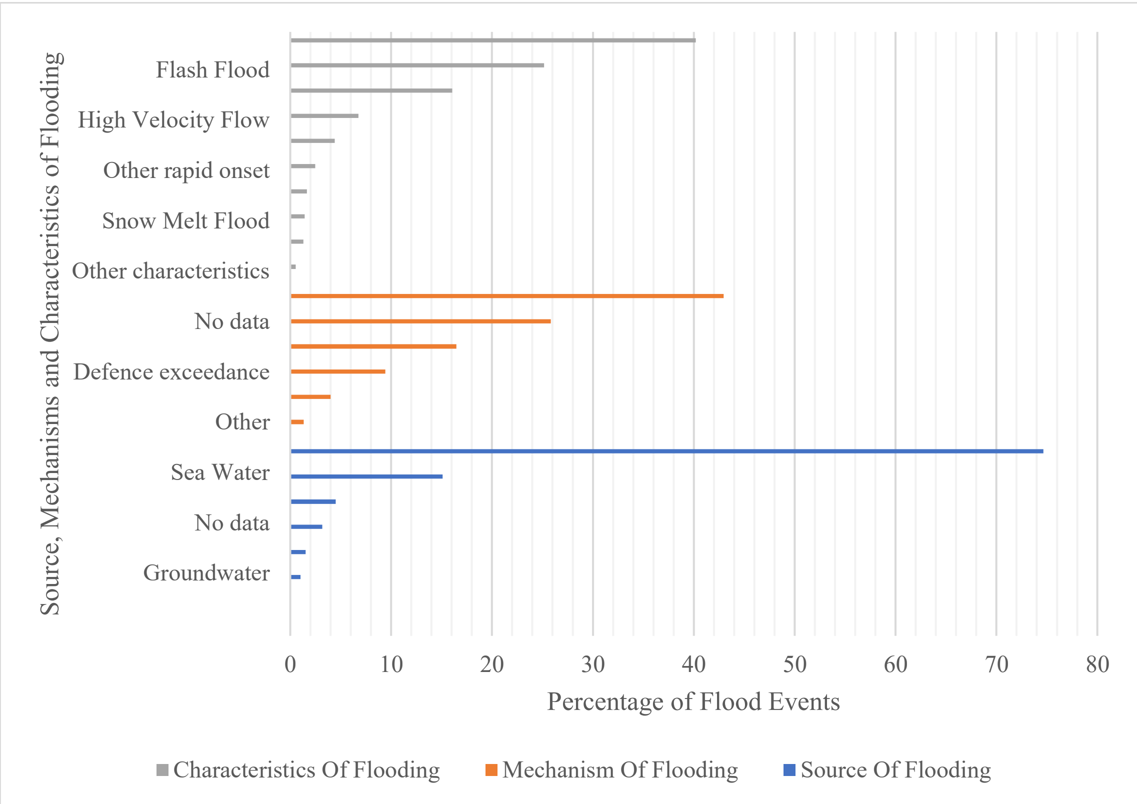
5.5. Article 4.2(d) - Assessment of future floods with potential adverse consequences regardless of significance

5.5.1. Sources, mechanisms and characteristics of future floods

Figure 20 shows the sources, mechanisms and characteristics of potential future flood events, predicted as a result of the assessment conducted according to Article 4.2(d). This shows that the source of the majority (three quarters) of floods is expected to be fluvial[73] flooding, followed by sea water[74] flooding (15%). Only 4.5% of floods are expected to be pluvial[75]. The main mechanism of flooding for future floods is reported to be natural exceedance (43% of floods), defined as "flooding of land by waters exceeding the capacity of their carrying channel or the level of adjacent lands". The most frequent characteristic of flooding is expected to be flash flooding (a quarter), although no data was reported for 40% of future floods identified. It is surprising that the proportion of pluvial floods expected is so low, this may however reflect uncertainty from the part of Member States about how to best deal with pluvial floods in the framework of the FD.

Figure 20: Sources, mechanisms and characteristics of future floods as reported to the EIONET CDR in the second cycle



[73] Flooding of land by waters originating from part of a natural drainage system, including natural or modified drainage channels. This source could include flooding from rivers, streams, drainage channels, mountain torrents and ephemeral watercourses, lakes and floods arising from snow melt.

[74] Flooding of land by water from the sea, estuaries or coastal lakes. This source could include flooding from the sea (e.g., extreme tidal level and / or storm surges) or arising from wave action or coastal tsunamis.

[75] Flooding of land directly from rainfall water falling on, or flowing over, the land. This source could include urban storm water, rural overland flow or excess water, or overland floods arising from snowmelt.

5.5.2. Methodologies and criteria used for the assessment of the significance of the consequences of future floods

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

Figure 21 shows the number of Member States where strong evidence or some evidence was found of a clear and distinct methodology being in place for the implementation of Article 4.2(d). This shows that all Member States have presented evidence of a methodology being in place, with half the Member States presenting strong evidence. A comparison of the numbers in Figure 14, Figure 18 and Figure 21 hints at Member States having expended more effort in assessing the consequences of future floods (considering also the requirement to identify APSFRs) than assessing the impacts of past floods. This forward-looking approach is intuitive, possibly justified, as long as there is reasonable confidence that the work done analysing past floods has yielded all the necessary information to reliably support the prediction and estimation of potential damage of future floods.

Figure 21: Number of Member States where there is strong or some evidence of a clear methodology being in place for the implementation of Article 4.2(d)

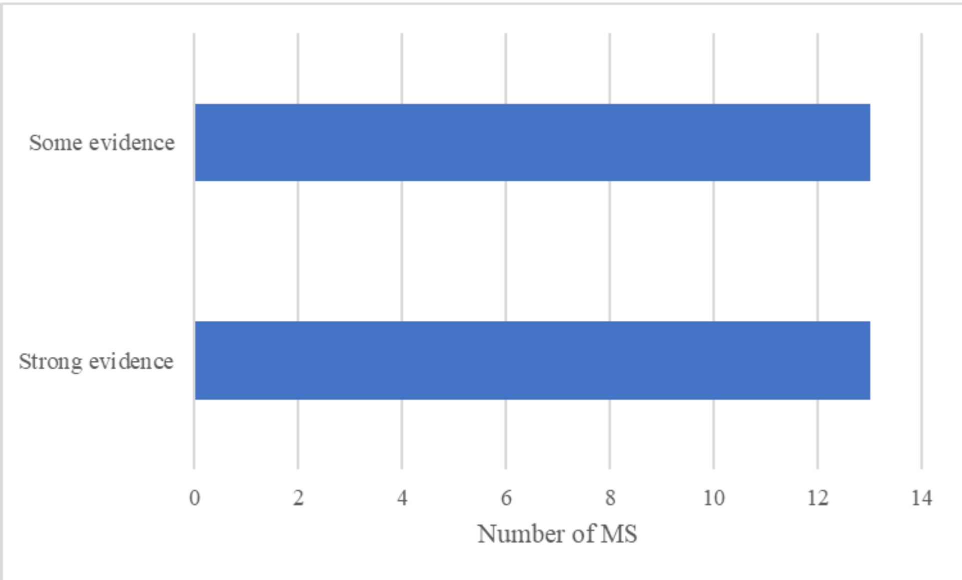


Figure 22 and Table 7 present the criteria used by the Member States to identify potential adverse consequences of floods based on the information reported. This shows that 86% of UoMs used the criterion “Potential number of permanent residents affected by the flood extent in flood plains”, 77% of UoMs used the criterion “Potential adverse consequences to economic activity (e.g. manufacturing, service and construction industries)”, 77% used the criterion “Potential adverse impacts on cultural assets and cultural landscapes” and 72% used the criterion “Potential adverse consequences to infrastructural assets”.

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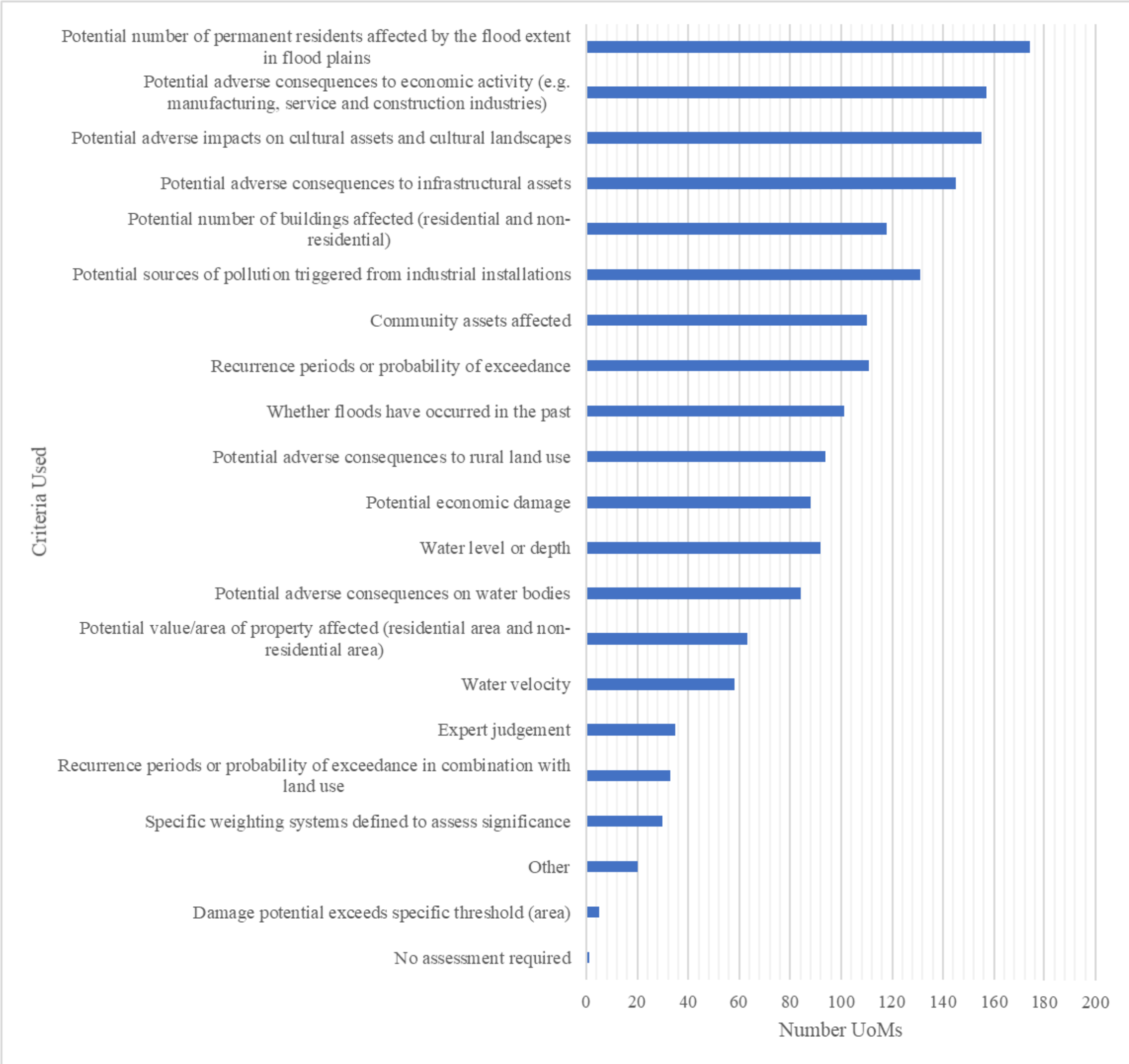
Figure 22: Criteria used to identify potential adverse consequences of future floods as required under Article 4.2 (d) as reported to the EIONET CDR in the second cycle



Note: More than one criteria can be applied for the assessment of the potential consequences of future floods.

At the other end of the scale, 16% of UoMs used the criterion "Recurrence periods or probability of exceedance in combination with land use"[76] and 15% of UoMs have applied specific weighting systems defined to assess significance[77]. The use of "other" criteria was reported by one out of every 10 UoMs, these included:

- Population development, overnight stays (fluctuations in the probability of stay due to tourism) (Austria),
- Adverse impacts on ecological assets; vegetation and habitats (Belgium),
- Inclusion of important contingency points in the risk mapping. Emergency points are police, fire brigade, emergency centres and hospitals (Denmark),

[76] All UoMs in Greece and Lithuania, 7 (out of 8) UoMs in Finland and some in Spain and Italy.
[77] All UoMs in DK, EE, HR, IE, LV, MT, SE and SK and some in Spain, and Italy.

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- Number fatalities, perception of risk, disruption of society, number of affected drinking water abstraction locations, number of affected bathing water locations, number of affected IED installations and damage potential exceeds specific monetary threshold (the Netherlands),

- Potential negative consequences for the environment (Natura 2000 sites and protected areas) (Poland).

Expert judgement was used by 17% of UoMs. Examples of how this was applied include:

- The assessment of the development of economic activity (Austria),

- Determining the consequences of future floods from a vulnerability matrix. Vulnerability data is collected by national data sets retrieved from a wide range of data providers. The vulnerability is indexed by expert assessment in collaboration with relevant authorities. The vulnerability categories included are Population, Land Use, Cultural Heritage, Infrastructure, Potentially Polluting Businesses, Contingency, Critical Infrastructure and Economic Activity (Denmark)[78].

- The inclusion of regional and local conditions in the assessment of flood risk (Finland).

Some Member States provided detailed information on the methodology used for defining future flood risk. For example, in mainland Finland the assessment of future flood risks is made using an altitude model and spatial data, which considers the location and hydrological and geomorphological characteristics of water bodies, the effectiveness of regulatory and flood defense structures and other available flood risk management measures, and long-term change of conditions, including climate change impacts[79]. Slovenia carried out a detailed GIS based analysis to evaluate future flood risk[80], whilst in Lithuania locations which are subject to future flood risk are identified by considering the location of significant past floods, topography, expected climate change impacts, location of water courses and their general hydrological and geomorphological characteristics. Once rivers or territories with future flood risks are identified, a detailed assessment of adverse consequences of future floods is performed[81]. Latvia used a detailed methodology for calculating the potential consequences of future flooding including the development of a social index to express risks to social groups[82].

The number of significant future floods identified by each Member State is shown in Figure 23.

[78] See case study 16 for Denmark at the end of this document.
[79] See case study 17 for Finland.
[80] See case study 18.
[81] See case study 19.
[82] See case study 20.

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Figure 23: Number of significant future flood events identified by Member States

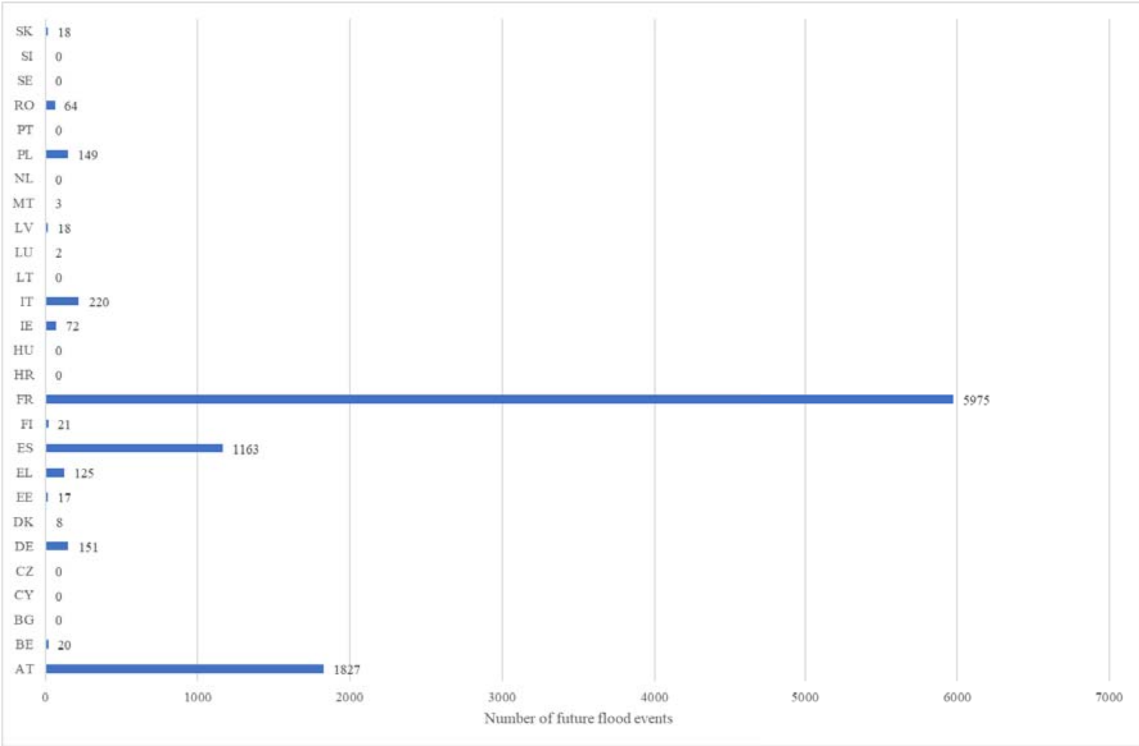

Table 7: Criteria used by each Member States to identify potential adverse consequences of future floods

MS	Potential number of permanent residents affected by the flood extent in flood plains	Potential value/area of property affected (residential area and non-residential area)	Potential number of buildings affected (residential and non-residential)	Potential adverse consequences to infrastructural assets	Damage potential exceeds specific threshold (area)	Potential economic damage	Potential adverse consequences on water bodies	Potential sources of pollution triggered from industrial installations	Potential adverse consequences to rural land use	Potential adverse consequences to economic activity (e.g. manufacturing, service and construction industries)	Potential adverse impacts on cultural assets and cultural landscapes	Recurrence periods or probability of exceedance	Recurrence periods or probability of exceedance in combination with land use	Community assets affected	Water level or depth	Water velocity	Whether floods have occurred in the past	Specific weighting systems defined to assess significance	Expert Judgement	Other	The specific needs of the of the Member States do not require an assessment under Article 4.2(d)
AT																					
BE	2 of 7					2 of 7					2 of 7	4 of 7					4 of 7		5 of 7	2 of 7	
CY																					
CZ																					
DE																					
DK																					
EE																					
EL																					
ES	16 of 25	3 of 25	15 of 25	12 of 25	1 of 25	6 of 25	4 of 25	5 of 25	9 of 25	11 of 25	8 of 25	8 of 25	2 of 25	6 of 25	7 of 25	7 of 25	4 of 25	4 of 25	11 of 25		
FI			7 of 8					7 of 8		7 of 8	7 of 8		7 of 8						7 of 8		
FR														13 of 14							
HR																					
HU																					
IE																					
IT		15 of 47	41 of 47			41 of 47							6 of 47	45 of 47	25 of 47	25 of 47	38 of 47	1 of 47			

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MS	Potential number of permanent residents affected by the flood extent in flood plains	Potential value/area of property affected (residential area and non-residential area)	Potential number of buildings affected (residential and non-residential)	Potential adverse consequences to infrastructural assets	Damage potential exceeds specific threshold (area)	Potential economic damage	Potential adverse consequences on water bodies	Potential sources of pollution triggered from industrial installations	Potential adverse consequences to rural land use	Potential adverse consequences to economic activity (e.g. manufacturing, service and construction industries)	Potential adverse impacts on cultural assets and cultural landscapes	Recurrence periods or probability of exceedance	Recurrence periods or probability of exceedance in combination with land use	Community assets affected	Water level or depth	Water velocity	Whether floods have occurred in the past	Specific weighting systems defined to assess significance	Expert Judgement	Other	The specific needs of the of the Member States do not require an assessment under Article 4.2(d)
LT																					
LU																					
LV																					
MT																					
NL																					
PL	7 of 9	7 of 9		7 of 9		7 of 9			7 of 9	7 of 9	7 of 9									7 of 9	
PT				1 of 11		10 of 11	9 of 11	9 of 11		1 of 11				1 of 11			1 of 11				
RO																					
SE																					
SI																					
SK																					

Key:

Criteria used in all UoMs
Criteria used in some UoMs
Criteria not known to have beem applied in any UoM

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5.5.3. Potential adverse consequences of future floods

Figure 24 shows the types of potential adverse consequences identified for future flood events in the Member States grouped by type of consequence. This shows that the expected consequences of future flooding for economic activity are slightly more pronounced than the consequences for human health, cultural heritage or the environment, with 17 Member States[83] considering consequences for economic activity (such as manufacturing, construction, retail, services and other sources of employment) and consequences for property (such as homes and businesses) and 15 Member States[84] considering 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 including fatalities. More Member States (16[85]) considered consequences to infrastructure (assets such as utilities, power generation, transport, storage and communication) than considered adverse consequences to the community (13 Member States[86]), such as detrimental impacts on local governance and public administration, emergency response, education, health and social work facilities (such as hospitals).

Adverse consequences to cultural heritage, which could include archaeological sites/monuments, architectural sites, museums, spiritual sites and buildings, have been considered by 14 Member States[87]; consequences for cultural heritage have been considered to be not applicable in some UoMs in 10 Member States[88]. Sources of potential pollution in the event of a flood, such as IPPC and Seveso installations, or point or diffuse sources have been considered by half the Member States[89], and adverse consequences to protected areas or waterbodies such as those designated under the Birds and Habitats Directives, bathing waters or drinking water abstraction points have been considered by 8 Member States[90]. Consequences of future flooding for the environment have been considered to be not applicable in at least one UoM in 11 Member States[91]. Information on this subject was not reported by 10 Member States[92].

[83] AT, BE, DE, DK, EE, EL, ES, FI, FR, IE, IT, LU, LV, MT, PL, RO and SK.
[84] AT, BE, DE, DK, EE, ES, FI, FR, IE, IT, LU, MT, PL, RO and SK.
[85] AT, BE, DE, DK, EE, EL, ES, FI, FR, IE, IT, LV, MT, PL, RO and SK.
[86] AT, DE, EE, ES, FI, FR, IE, IT, LV, MT, PL, RO and SE.
[87] BE, DE, DK, EE, EL, ES, FI, FR, IT, LU, LV, PL, RO and SK.
[88] AT, DE, EE, ES, FI, IT, LV, PL, RO and SK.
[89] AT, BE, DE, DK, EE, ES, FI, SR, IE, IT, LV, PL, RO and SK.
[90] AT, BE, DE, ES, FI, IT, LV and PL.
[91] AT, BE, EE, EL, ES FI, FR, IT, PL, RO and SK.
[92] BG, CY, CZ, HR, HU, LT, NL, PT, SE and SI.

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Figure 24: Potential consequences that have been considered in the assessment of future floods as reported to the EIONET CDR in the second cycle

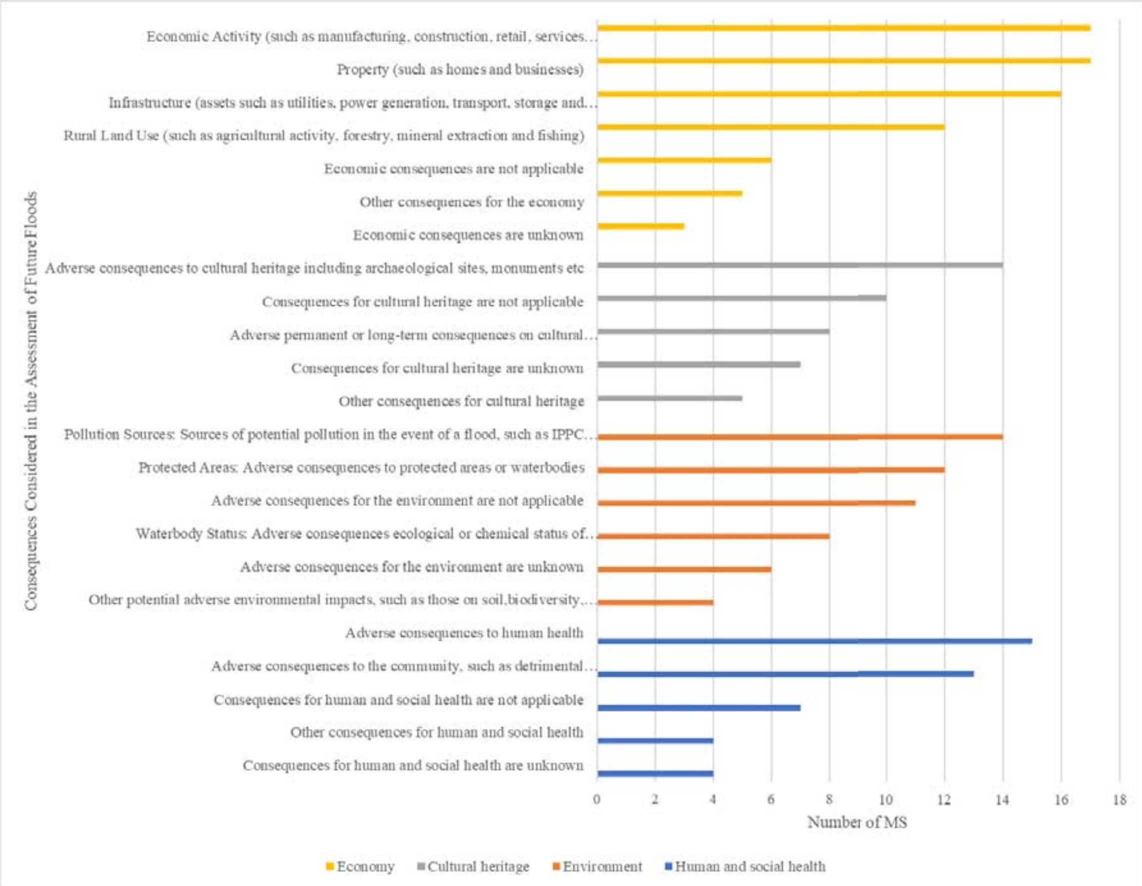

Figure 25 shows the number of future flood events that have been identified as potentially resulting in adverse consequences. This shows that future floods are expected to have consequences for:

- Property (such as homes and businesses);
- Infrastructure (assets such as utilities, power generation, transport, storage and communication);
- 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;
- Economic Activity (such as manufacturing, construction, retail, services and other sources of employment); and
- Community, such as detrimental impacts on local governance and public administration, emergency response, education, health and social work facilities (such as hospitals).

Consequences are also expected to be seen for the environment and cultural heritage for a large number of future flood events, but the exact nature of these consequences has not been reported and/or is unknown.

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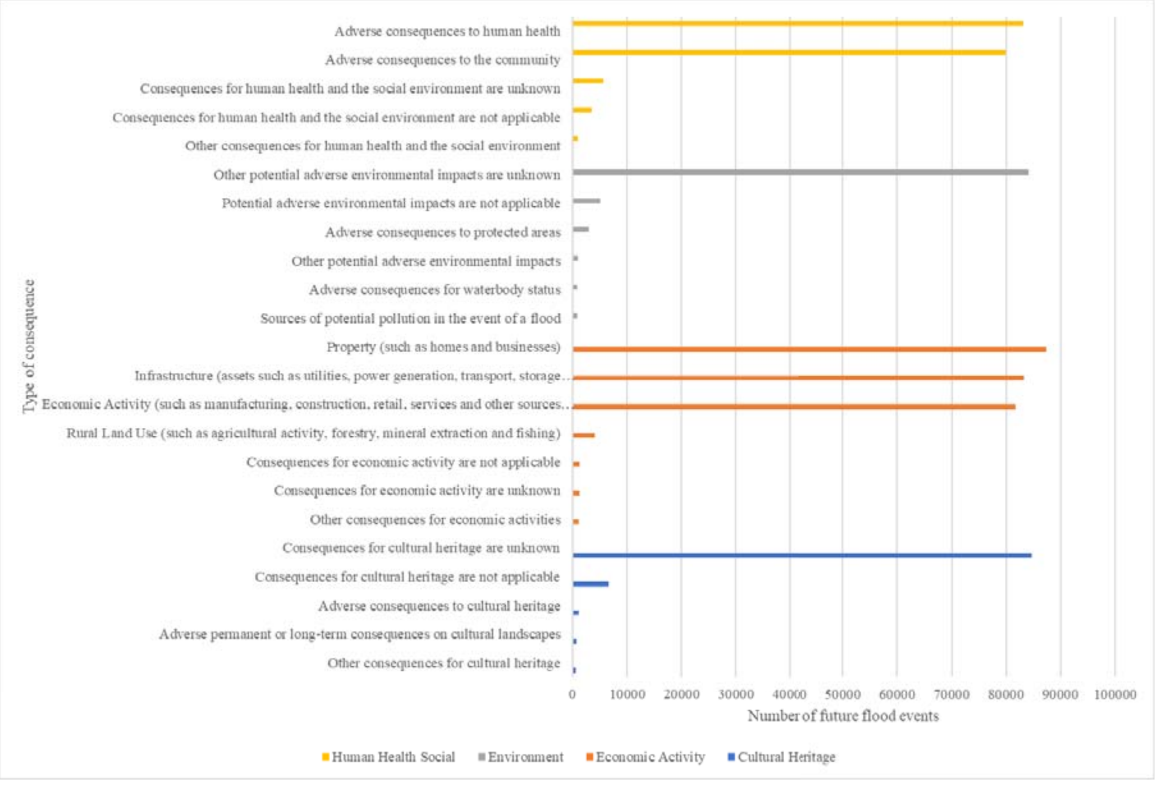
Figure 25: Number of future flood events that have been identified as potentially resulting in the consequences identified as reported to the EIONET CDR in the second cycle



5.5.4. Issues considered in the assessment of adverse consequences of future floods

During the assessment of potential adverse consequences of future floods, Member States are required to take into account possible issues as specified in Article 4.2(d). Figure 26 shows the number of Member States that have considered each issue. The position of watercourses and their general hydrological and geomorphological characteristics has been considered by nearly nine out of ten Member States, and the position of populated areas by 85%. Areas of economic activity has been considered by slightly over four fifths of Member States, whilst the effectiveness of man-made infrastructures and topography have each been considered by slightly under four fifths of Member States. At the other end of the scale, long term developments appear to have been considered the least with just under half of Member States considering the development of settlements (private, public and commercial), 40% considering the development of infrastructure (transport, water, energy and telecoms) and lightly over a quarter considering rural land use change.

Figure 27 shows where the results of the Commission's assessment indicate whether there is strong evidence, some evidence, or no evidence, of the issues having been assessed. The strongest evidence has been presented for the consideration of the position of populated areas, topography, the position of watercourses and their general hydrological and geomorphological characteristics, and areas of economic activity. Evidence has been presented by nearly nine out of ten Member States for the consideration of hydrological and geomorphological characteristics (including the use of floodplains as natural retention areas) but in a half of these cases the methodology is not completely clear. Only eight

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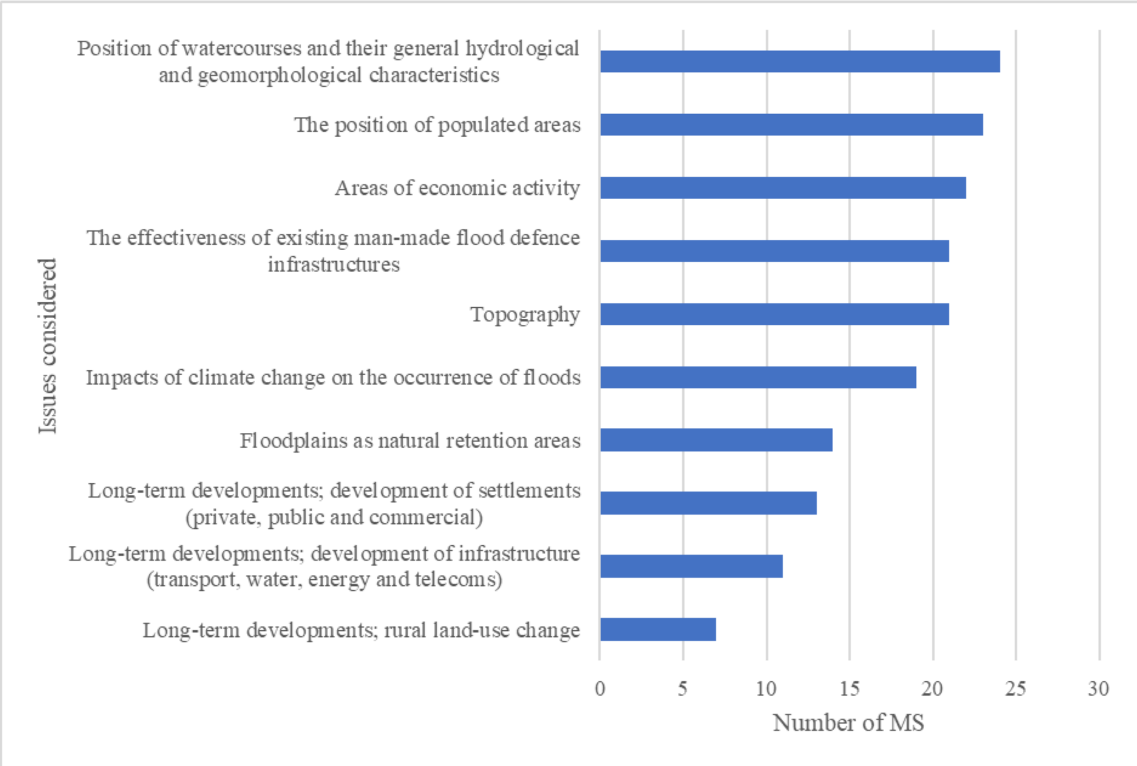
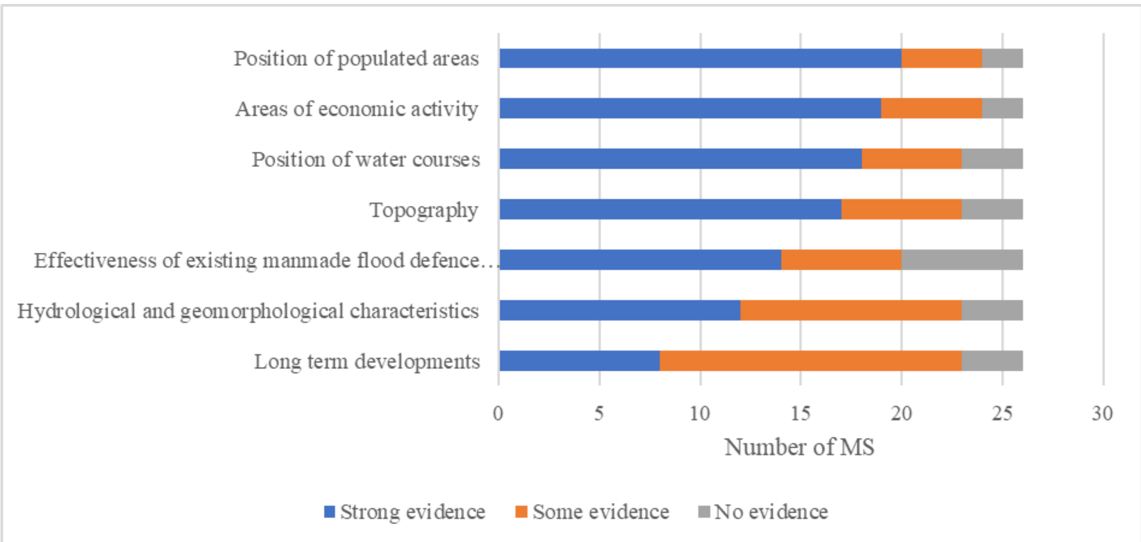
Member States[93] presented strong evidence of the consideration of long-term developments including the impact of urbanisation and climate change.

Figure 26: Issues considered by the Member States in the assessment of adverse consequences as reported to the EIONET CDR in the second cycle



Note: More than one issue may be considered.

Figure 27: Number of Member States where there is strong, some, or no evidence of the consideration of possible issues in connection to future floods



[93] BE, EE, FI, HR, HU, MT, PL and SK.

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Figure 28 shows the percentage of UoMs in the Member States that have considered long term developments (settlements, infrastructure and rural developments) in the assessment of future floods in the second cycle, whilst Table 8 shows how this has changed from the first cycle.

Only four Member States[94] have considered all three types of development in all UoMs. Three more[95] have considered the development of settlements and infrastructure in all UoMs, Ireland has considered the development of settlements and rural developments in all UoMs, whilst Belgium has considered all types of development, but infrastructure and rural developments have only been considered in some UoMs. In Finland, the development of settlements and infrastructure has been considered in all but one UoM. Croatia has considered the effect of the development of infrastructures in all UoMs, and Romania has considered the development of settlements in all UoMs. Twelve Member States did not consider the effect of long-term developments of future flood risk[96].

Comparing the first cycle to the second cycle, eleven Member States[97] who had applied Article 13, or had not reported in the first cycle now report that they have considered the effect of the development of settlements on future flood risk in all or some UoMs and nine Member States[98] who had applied Article 13 or had not reported, now report that they have considered the effect of the development of infrastructure. Two Member States (Austria and Cyprus) reported in the first cycle that long term developments of settlements and infrastructure were considered in the assessment of future flood risk reported the same in the second cycle. However, Czechia, which reported considering developments of settlements and infrastructure in the first cycle, and Slovenia and Slovakia which considered developments of settlements only in the first cycle, reported that these are no longer taken into consideration. However, in the case of Slovakia, evidence was provided in the PFRA that the impact of long term developments on the incidence of flooding is taken into consideration.

In summary, the consideration of the effect of long term developments on future flood risk has improved in the second cycle, but some Member States should still consider including these factors in their assessments. Member States can also make use of the Risk and Recovery Mapping component of the Copernicus Emergency Management Service[99] to support the assessment of potential future impacts of floods as well as risk assessments for specific areas.

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[94] DE, EE, NL and PL. See case study 21 at the end of this document.
[95] AT, CY and SE.
[96] CZ, DK, EL, FR, HU, IT, LT, LU, MT, PT, SI and SK.
[97] BE, DE, EE, ES, FI, IE, LV, NL, PL, RO and SE.
[98] BE, DE, EE, ES, FI, HR, NL, PL and SE.
[99] https://emergency.copernicus.eu/ The Risk and Recovery Mapping Portfolio service consists of the on-demand provision of geospatial information. This information supports emergency management activities not related to the immediate response phase. This service addresses prevention, preparedness, disaster risk reduction or recovery phases

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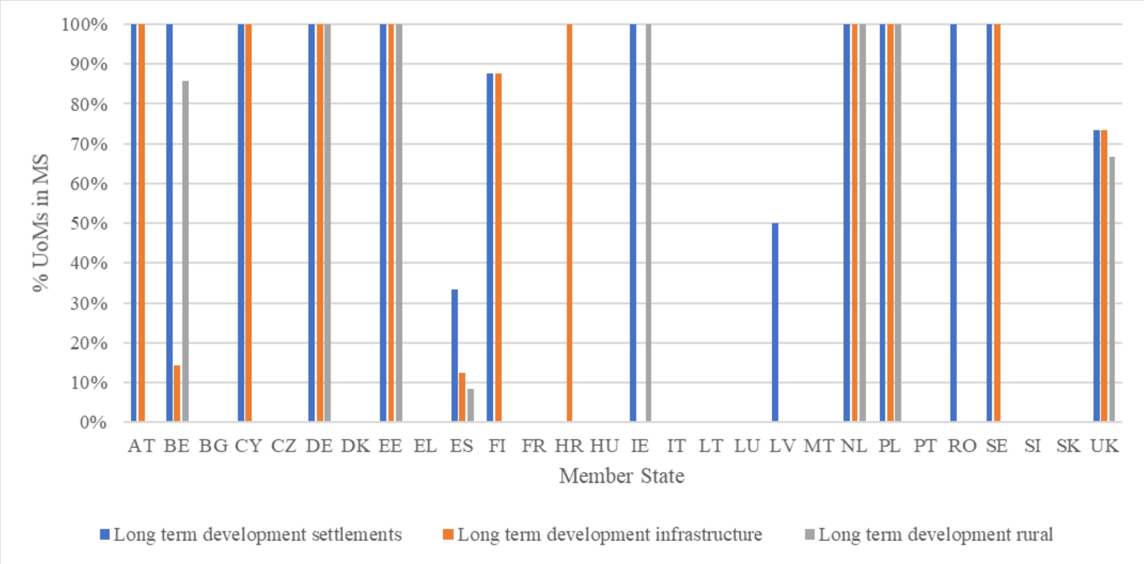
Figure 28: Proportion of UoMs in each Member States that have considered long term developments in the second cycle



Note: Bulgaria did not report in time to be considered in the Commission's assessment of Member States' PFRAs.

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Table 8: Comparison of Member States first and second cycle approaches to the consideration of the development of settlements and the development of infrastructure[100]

MS	Development of settlements		Development of infrastructure	
	First cycle	**Second cycle**	**First cycle**	**Second cycle**
AT				
BE	13.1(b) applied		13.1(b) applied	In 1 of 7 UoMs
BG	Did not report in time for the Commission's assessment			
CY				
CZ				
DE				
DK				
EE				
EL				
ES		In 8 of 24 UoMs		In 3 of 24 UoMs
FI		In 7 of 8 UoMs		In 7 of 8 UoMs
FR				
HR				
HU				
IE				
IT	13.1(b) applied but some preliminary work is available		13.1(b) applied but some preliminary work is available	
LT				
LU	13.1(a) applied		13.1(a) applied	
LV		In 2 of 4 UoMs		
MT				
NL	13.1(b) applied		13.1(b) applied	
PL				
PT				
RO				
SE				
SI				
SK				

Note: Germany also applied Articles 13.1a and 13.1b in some UoMs in the first cycle.

Key:

First Cycle	Second Cycle
Long term trend considered	Long-term trend considered in all UoMs
	Long term trend considered in some UoMs
Long-term trend not considered	Long-term trend not considered
Information not reported	Information not reported

[100] The effect of long term rural development was not considered in the first cycle so no comparison could be made.

5.6. PFRA aspects of special interest

5.6.1. Pluvial floods (flash floods) in urban settings

As stated above, nearly seven out of every 10 flood events were reported to have the characteristics of a flash flood, and slightly under 3 out of every 10 events were characterised as other rapid onset floods. Flash floods usually happen because of extreme rainfall events occurring in a small area and might be expected to result in pluvial flooding. However, only 45% of flood events were reported as pluvial flooding. "No data" has been reported for the characteristics of slightly over a quarter of floods, and it is therefore likely that the proportion of flood events that are flash floods is understated. Predicting and managing pluvial flash floods is challenging, but it is recommended that further efforts are made in the third cycle to collect and report data on pluvial flash floods such that trends in their occurrence can be identified.

5.6.2. Inclusion/exclusion of floods from sewerage systems

According to the FD, *'flood' means the temporary covering by water of land not normally covered by water and…may exclude floods from sewerage systems*. A flood from a sewerage system is not the same as a flood related to a (combined) sewerage system. Floods from sewerage systems are not excluded from the scope of the FD, although Member States may exclude them as they might be insignificant and localised, e.g. when the basement of a single house is flooded because the non-return valve of the pipe connecting it to the sewerage network failed. This is a flood from a sewerage system. On the other hand, floods related to a (combined) sewerage system (or a stormwater system) can be significant, either because the system is outdated, under-dimensioned, not properly maintained, or overwhelmed by extraordinary rain.

Floods related to (combined) sewerage systems (and stormwater systems) merit therefore consideration in conjuction to flash flooding/pluvial flooding, particularly in dense urban areas. Figure 29 shows the number of UoMs that have included and excluded flooding from sewerage systems in the PFRA. This shows that slightly over a third of UoMs from six Member States[101] have considered flooding from sewerage systems in their risk assessments and, of those, only four Member States, Denmark, Greece, Lithuania and Romania, have included this source in the risk assessment in all UoMs.

[101] BE, DK, EL, IT, LT and RO.

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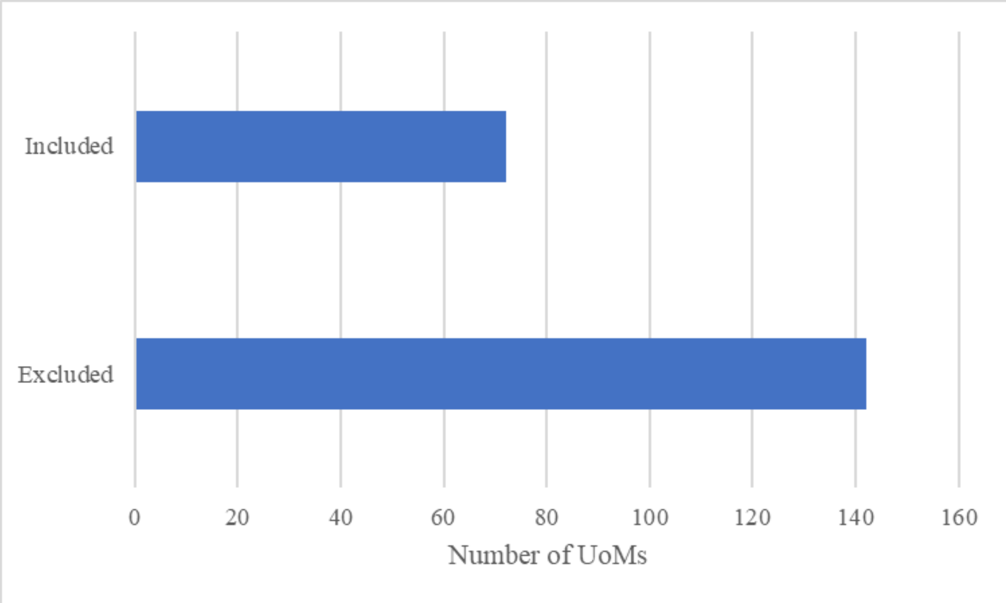
Figure29: Number of UoMs that have included/excluded flooding from sewerage systems



5.6.3. Consideration of impacts of past floods and consequences of future floods on the environment and cultural heritage

In the first cycle the impact of past floods on the environment was reported for a bit over one fifth of past events and the impact on cultural heritage was reported for 15% of past events. The report noted that this was likely to be due to a lack of available data as traditionally the impact of flooding had been reported in terms of impact on human health and the economy. The potential consequences of future flooding on the environment was reported for 45% of events and on cultural heritage for a bit over one third of events.

It is clear from the information presented that some consideration has been given in the second cycle to the impacts of past floods and consequences of future floods on the environment and cultural heritage. However, it would appear at first glance that it is again the economy and human health that are more at risk or that most emphasis has been placed on impacts and consequences to economic activities and human health.

Figure 30 shows where the Commission's assessment indicates that there is strong, some or no evidence of a description of the impact of past flooding on human health, the environment, cultural heritage and economic activity. This shows that most Member States (nine out of every ten) presented some evidence or strong evidence of having considered the impact of past floods on human health and economic activity. For one Member States (Luxembourg) no evidence was found in the reported information of any impacts being considered (although there may have been none), whilst for one Member State (Lithuania), only economic impacts were considered and for another (Denmark) only impacts on human health were considered. Evidence of the assessment of the impact of past floods on cultural heritage was presented by three quarters of Member States; for six[102] no evidence was found in the reported information. Similarly, evidence of the assessment of the impact of past floods on the environment was presented by nearly three quarters of Member States, while for seven[103] no evidence was found in the reported information. It should be pointed out that, although most Member States presented at least some evidence, in most cases gaps were identified in the evidence presented. Strong evidence on the assessment of

[102] DK, EL, FR, LT, LU and MT.
[103] DK, EL, FR, LT, LU, MT and NL.

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impacts of past floods was presented in by a third of Member States for all categories of impact. The data reported on the impact of past floods indicated that the impact of past floods on the environment is less of a concern or has been less well assessed. From the evidence presented, there appears to be little difference in the quality of the methodologies across the categories of impact.

Figure30: Number of Member States where there is strong, some, or no evidence of a description of the impact of past flooding on human health, the environment, cultural heritage, and economic activity

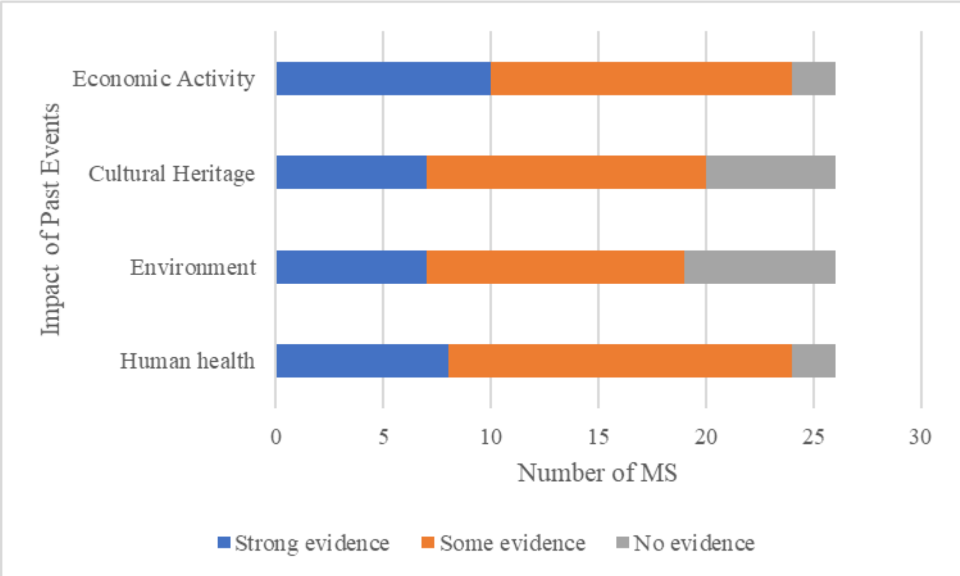

Figure 31 shows where the results of the Commission's assessment indicates that there is strong, some or no evidence of an assessment of the potential adverse consequences of future flooding on human health, the environment, cultural heritage and economic activity. This shows that almost all Member States presented some evidence or strong evidence of having considered the consequences of future floods on human health with only one Member State (Portugal) presented no evidence in the reported information. Strong or some evidence of the assessment of the consequences of future floods on cultural heritage and the environment was presented by slightly over nine out of ten Member States with two (Czechia and Portugal) presenting no evidence in the reported information. Evidence of the assessment of consequences on economic activity was presented by nearly nine out of ten Member States with three (Czechia, Portugal and Slovakia) presenting no evidence in the reported information. It should be noted, that in general, as was the case with methodologies for identifying future floods, the evidence for the assessment of the consequences of future floods is stronger than for the assessment of the impact of past floods. There appears to be little difference in the quality of the methodologies for the assessment of consequences of future flooding between the four different impact categories.

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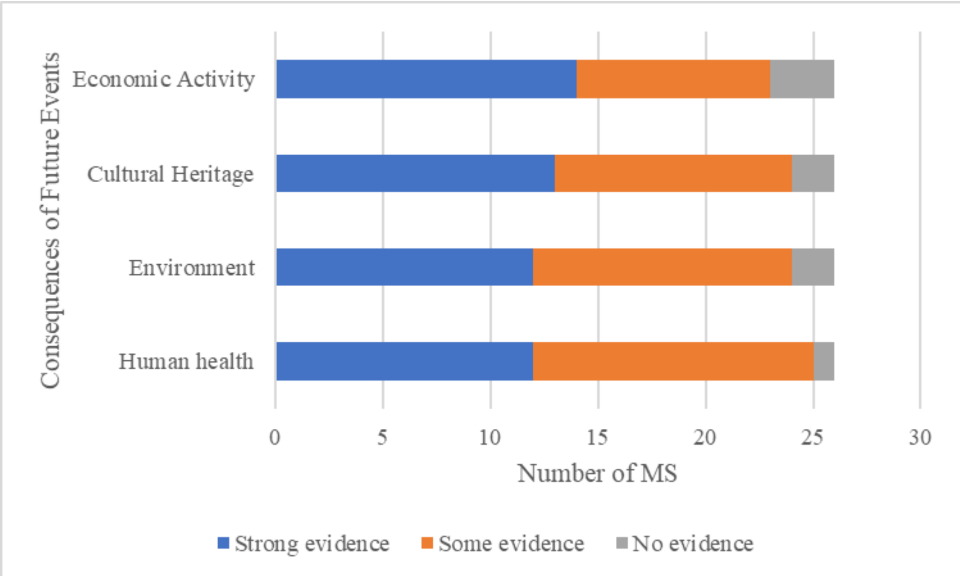
Figure 31: Number of Member States where there is strong, some, or no evidence of a description of the consequences of future flooding on human health, the environment, cultural heritage, and economic activity



5.6.4. Use of expert judgement in the PFRAs

In the first cycle's assessment of Member States' PFRAs it was noted that "Many Member States have applied expert judgement or a qualitative manner to define adverse consequences". In the second cycle Member States have continued to use "Expert Judgement" to determine the impact of past flooding and the likely consequences of flooding in the future. In nearly all cases, expert judgement is used in conjunction with other assessment criteria. In some cases, it provides more information into the assessment that can only be obtained at a local level, for example, the approach to the assessment of past floods in Poland, or the approach taken in Sweden for the assessment of the past floods with hitherto no significant impact. In other situations, it is used to verify the results of the analysis. For example, in Romania, expert judgement is used as the final step in the process to identify significant past floods, whilst in Germany, the results of the PFRA are checked for plausibility by local experts before the APSFRs are selected. In Austria, the "preliminary risk assessment" underwent a local/regional revision and amendment, in which local circumstances, existing or new protection measures etc. were included into the assessments prior to the APSFRs being identified.

On the other hand, in Croatia, expert judgement is used to identify past floods which had no impact in the past, but which may be significant in the future (application of Article 4.2(c)). Croatia also uses local knowledge for the assessment of future flood risk (application of Article 4.2(d)), which is usually carried out by specialist and local staff of the water management authorities, with the involvement of local authorities and, if necessary, other relevant local experts.

There is a role for the use of expert judgement, particularly where the knowledge of the local situation can enhance the risk assessment. However, the basis for its application should be clear and transparent.

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5.6.5. Risks with low probability – high impact (e.g. dam failure)

Some types of flood have a very low probability of occurring, but could have high, if not catastrophic consequences should they occur. An example of such a flood would result from dam failure. Twelve Member States[104] have clearly indicated in their reporting that they have included floods from artificial water bearing infrastructure in the PFRA, however this has a wide definition and can also include urban drainage structures.

Poland carried out a detailed assessment of the possibility and consequences of flooding as a result of dam failure, leading to the designation of 26 APSFRs[105]. France has included the risk of dam failure in the national indicators for the determination of flood risk[106]. Romania mentioned the risk of dam failure in its assessment but mainly stated that due to the low probability of such an occurrence that the consequences of dam failure have not been considered. However, it did state that the regulations for the operation of dams and reservoirs and plans for action in the event of accidents at dams will be reviewed, taking account of the effects of climate change. Croatia has stated in its methodology that flooding from dam failure is included in the flood hazard maps but has not provided information on how the risks have been calculated. Latvia has assumed in the development of its indicators that all floods will occur gradually and that instantaneous floods such as the failure of hydroelectric dams will not occur. Finland did not indicate that it had included artificial water bearing infrastructure in the PFRA, however, it has included the potential consequences of the failure of both ice dams and reservoir dams in the assessment of future flood risk.

Other types of potential catastrophic events have been considered. For example, Slovenia has included maps of areas at risk of torrential flooding in the online map viewer.

In general, the main focus of the PFRAs has been on the risks of flooding that are most likely to occur, and less consideration has been given to those risks that are less likely, but which would have greater consequences should they occur. This is an area of risk assessment that should be given greater emphasis in the third cycle.

5.7. Changes in Article 4's assessments since the previous cycle

5.7.1. Article 4.2(b) – developments since the previous cycle

A general comment to make when comparing between the first and second cycle is that for some Member States certain aspects of the PFRA of the second cycle may be an update or an improvement of the first. In this case it may not have been necessary to return to some topics or to not present other at full length. Where this is the case, or were this to be the case, however, this should be explained clearly in the PFRA and proper references provided to the documents holding the full information.

The EU overview document from the first cycle[107] found that by far the most common source of reported historical flood events was fluvial (slightly above two thirds of reported events) followed by pluvial (slightly under a fifth) and sea water (17%). The least common was for artificial water bearing infrastructure and groundwater (both 1%). The most

[104] BE, CY, FR, HR, IE, IT, LT, LV, NL, PL, PT and RO.
[105] See Case Study 22 at the end of this document.
[106] See Case Study 23.
[107] https://ec.europa.eu/environment/water/flood_risk/pdf/pfra_reports/EU%20PFRA%20Overview%20Report.pdf

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common mechanism was natural exceedance (54% of events). In general, the characteristics of flooding were less often reported for historical floods with around 15% of events having no data on this aspect. In the second cycle, the most frequent source of floods remains fluvial, but a higher proportion of floods caused by seawater has been reported than pluvial flooding. Both however seem to have risen in importance or given more attention compared to the first cycle. The proportion of floods for which the mechanisms and characteristics are not known remains high. This points towards increasing the effort of recording information around flood events in order to prepare better responses in the future.

The EU overview document from the first cycle found that six Member States[108] had **excluded** flooding from sewerage systems. It was not clear whether the other Member States had excluded this source or not. In the second cycle, two Member States stated that they had **included** flooding from sewerage systems in the PFRA in some UoMs (Belgium and Italy) and four Member States (Denmark, Greece, Lithuania and Romania) included this source in the assessment in all UoMs.

In the first cycle, the level of detail in information provided by the Member States on the methodology and criteria used to define significant past floods was variable. Furthermore, a number of Member States applied Article 13 (and therefore did not report on this aspect) which does not apply to the second cycle. In the second cycle, all Member States provided some information on how past floods have been assessed and the criteria used for defining significance. In some Member States detailed information on how the criteria and methodologies have been applied are lacking, but in others the methodology is clear and detailed. In addition, "expert judgement" has been relied upon to a lesser extent, mainly being used to verify the results of analysis on the basis of local knowledge.

An assessment of the information reported on the impact of past floods was not included in the first cycle EU overview report. In this respect, the information provided in the second cycle marks an improvement. However, in the second cycle, the quality of information on the impact of past floods is variable, with some Member States only providing a qualitative assessment, while others providing more detailed quantitative data. In some cases more detailed information was available in supporting documents than was reported directly to the EIONET CDR.

In the first cycle EU overview report it was found that "not applicable" was identified for cultural heritage for 72% of past flood events, for environment for 59% of events, for human health for 45% of events and for economic impacts for 16%. At face value it appears that the proportion of past events where impacts on cultural heritage, the environment and human health were not applicable has increased in the second cycle, which implies that the recorded impact of flood events is reducing to these receptors. In terms of impacts on the economy, a higher proportion of events appear to have impacted on infrastructure than in the first cycle (47% vs. ~30%) but it should be noted that the first cycle analysis did not include information from all Member States.

5.7.2. Article 4.2(d) -developments since the previous cycle

The EU overview document for the first cycle concluded that the Member States' approaches and methodologies for the assessment of the consequences of future floods are very diverse. Several Member States reported that there was a lack of data and, consequently, it was difficult to make a detailed assessment of potential adverse

[108] DE, FI, IE, LT, LV and MT.

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consequences of future floods. Some Member States were not clear on what criteria were used to define potential adverse consequences. It was not clear whether they had not applied criteria, or if they had not reported the application of criteria to the Commission. In the second cycle all Member States have presented some level of evidence of a methodology being in place for the assessment of future floods and some have developed detailed methodologies for identifying future flood risk.

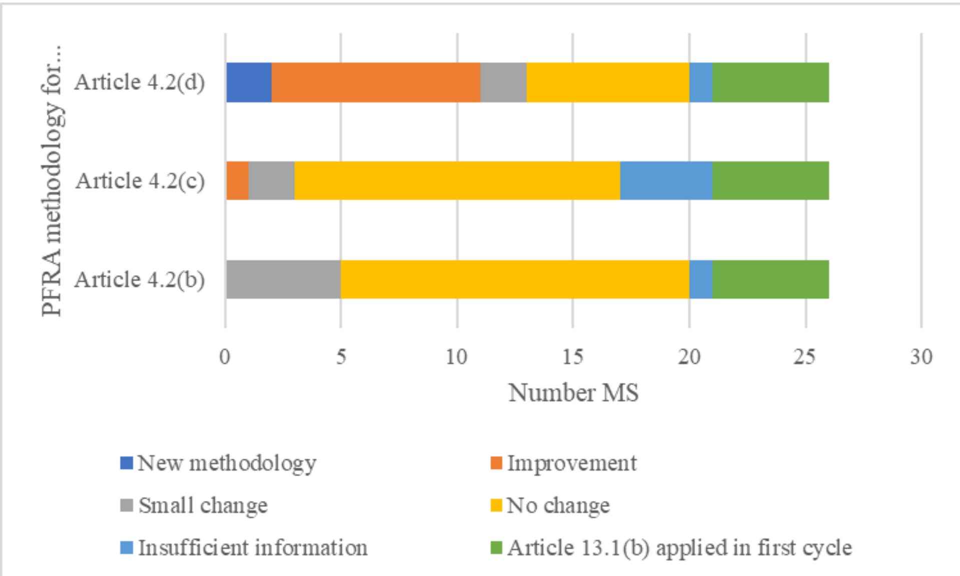
In the first cycle the assessment of the potential consequences of future floods focussed on consequences for the economy and human health. In the second cycle there seems to have been a more complete assessment of the consequences of future floods (compared to historic floods) in that proportionally fewer events were reported to have “not applicable” consequences for all four aggregated categories (economy, human health, environment and cultural heritage). This may be the case since for the second cycle historic floods have taken place more recently and also Member States may have been better prepared to record or anticipate their consequences.

5.7.3. Changes to the methodologies of Articles 4.2(b), 2(c) and 4.2(c) since the previous cycle

Figure 32 summarises the changes made to methodologies for the preparation of the PFRA by Member States. The changes made by each Member States are shown in Table 9. These clearly shows that a significant number of Member States have made changes to the methodologies for the identification of future floods, with two Member States (Latvia and Malta) adopting a completely new methodology for the application of Article 4.2(d). Nine other Member States[109] have improved their methodologies for the application of Article 4.2(d). Fewer Member States have made changes to the methodologies used for the assessment of past floods.

Table 10 shows changes made to the criteria for identifying significant past and future floods between the first and second cycle.

Figure 32: Changes in PFRA methodologies between first and second cycles



Note: Bulgaria did not report in time to be included in the Commission’s assessment.

[109] CY, DE, DK, EL, HR, IE, PL, SE and SI.

Table 9: Changes in PFRA methodologies between first and second cycles by Member States

MS	Article 4.2(b)	Article 4.2(c)	Article 4.2(d)
AT	No change	No change	Small change in methodology
BE	Article 13.1 applied in first cycle	Article 13.1 applied in first cycle	Article 13.1 applied in first cycle
BG	Did not report in time for the Commission’s assessment		
CY	No change	No change	Improvement in methodology
CZ	No change	Small change in methodology	No change
DE	No change	No change	Improvement in methodology
DK	No change	Improvement in methodology	Improvement in methodology
EE	No change	No change	No change
EL	Small change in methodology	No change	Improvement in methodology
ES	No change	No change	No change
FI	Small change in methodology	No change	Small change in methodology
FR	No change	No change	No change
HR	No change	Insufficient information reported	Improvement in methodology
HU	No change	No change	Insufficient information reported
IE	Insufficient information reported	No change	Improvement in methodology
IT	Article 13.1 applied in first cycle	Article 13.1 applied in first cycle	Article 13.1 applied in first cycle
LT	No change	No change	No change
LU	Article 13.1 applied in first cycle	Article 13.1 applied in first cycle	Article 13.1 applied in first cycle
LV	Small change in methodology	Insufficient information reported	New methodology
MT	No change	No change	New methodology
NL	Article 13.1 applied in first cycle	Article 13.1 applied in first cycle	Article 13.1 applied in first cycle
PL	Small change in methodology	Insufficient information reported	Improvement in methodology
PT	Article 13.1 applied in first cycle	Article 13.1 applied in first cycle	Article 13.1 applied in first cycle
RO	No change	No change	No change
SE	No change	No change	Improvement in methodology
SI	Small change in methodology	Small change in methodology	Improvement in methodology
SK	No change	Insufficient information reported	No change

Key:

New methodology
Improvement in methodology
Small change in methodology
No change
Insufficient information reported
Article 13.1 applied in first cycle

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Table 10: Changes in the criteria for identifying significant past and future floods between the first and second cycles

MS	Criteria for identifying significant past floods	Criteria for identifying significant future floods
AT	No change	No change
BE	Article 13.1 applied in first cycle	Article 13.1 applied in first cycle
BG	Did not report for the Commission's assessment	
CY	No change	No change
CZ	No change	Change in criteria
DE	No change	Change in criteria
DK	No change	Change in criteria
EE	No change	No change
EL	Change in criteria	No change
ES	No change	No change
FI	Change in criteria	Change in criteria
FR	No change	Article 13.1 applied in first cycle
HR	No change	No change
HU	No change	No information
IE	Change in criteria	No change
IT	Article 13.1 applied in first cycle	Article 13.1 applied in first cycle
LT	No change	No information
LU	Article 13.1 applied in first cycle	Article 13.1 applied in first cycle
LV	Change in criteria	Change in criteria
MT	Change in criteria	Change in criteria
NL	Article 13.1 applied in first cycle	Article 13.1 applied in first cycle
PL	No change	Change in criteria
PT	Article 13.1 applied in first cycle	Article 13.1 applied in first cycle
RO	No change	Change in criteria
SE	No change	No change
SI	Change in criteria	No change
SK	No change	No information
UK	Article 13.1 applied in first cycle	Change in criteria

Key:

Change in criteria
No change
No information
Article 13.1 applied in first cycle

5.7.4. Distinction between Articles 4.2(b) and 4.2(c) or 4.2(c) and 4.2(d)

As discussed in earlier sections, in many cases strong evidence of methodologies that made a clear distinction between Articles 4.2(b) and 4.2(c) and Articles 4.2(c) and 4.2(d) could not be identified. Indeed, only six Member States[110] provided clear evidence of a specific methodology for Article 4.2(c).

Some Member States appear to have considered floods with no impact under Article 4.2(b). For example, Spain and Portugal reported identical criteria for Articles 4.2(b) and 4.2(c) but provided no distinct methodology.

Some Member States included the assessment of past floods with no impact into the assessment for future floods (Article 4.2(d)). For example, Finland considered past floods with no impact in their assessment of future floods and applied the same criteria.

Other Member States, such as Luxembourg, applied only one methodology to the assessment of both past and future floods.

Estonia, mentioned the consideration of areas that had flooded in the past, but where the impact was not significant, in the section of the PFRA on the selection of APSFRs, but did not elaborate a detailed methodology. Similarly, Hungary mentioned that such floods should be considered in light of current circumstances but did not state how this should be achieved. Lithuania did not consider that the consequences of floods in the future would change from what had occurred in the past.

Nine Member States[111] presented no evidence in their reporting of having given a consideration to past floods with no significant impact or whether they may occur again in the future.

Although the FD is not prescriptive on how the assessment of past floods without a significant impact should be considered, Member States should consider having a methodology in place to assess whether such floods may re-occur and if so, what their impact may be due to altered socioeconomic circumstances or climate change.

6. Implementation of Article 5 - APSFRs

6.1. Methodologies and criteria used for the selection of APSFRs

Article 5 of the Directive requires Member States to use their PFRA analyses to identify areas for which they conclude that potential significant flood risk exists or might exist in the future for each river basin district, each UoM or portion of international UoM that lies within their territory. Of all the past and future floods analysed during the PFRA phase only the floods deemed of significance for the present and the future are retained as APSFRs.

All Member States provided information on the methodology used for the selection of APSFRs, and these were assessed to determine the level of detail included with the methodologies. To better appreciate the granularity of the methodologies, an assessment of whether the Member States' methodologies included criteria to distinguish between present day/future floods and **significant** present day/future floods was made for each Member State. Figure 33 summarises the results of these assessments. This shows that half

[110] BE, DE, DK, HR, IE and RO.
[111] AT, EL, FR, IT, LV, MT, NL, PL and SE.

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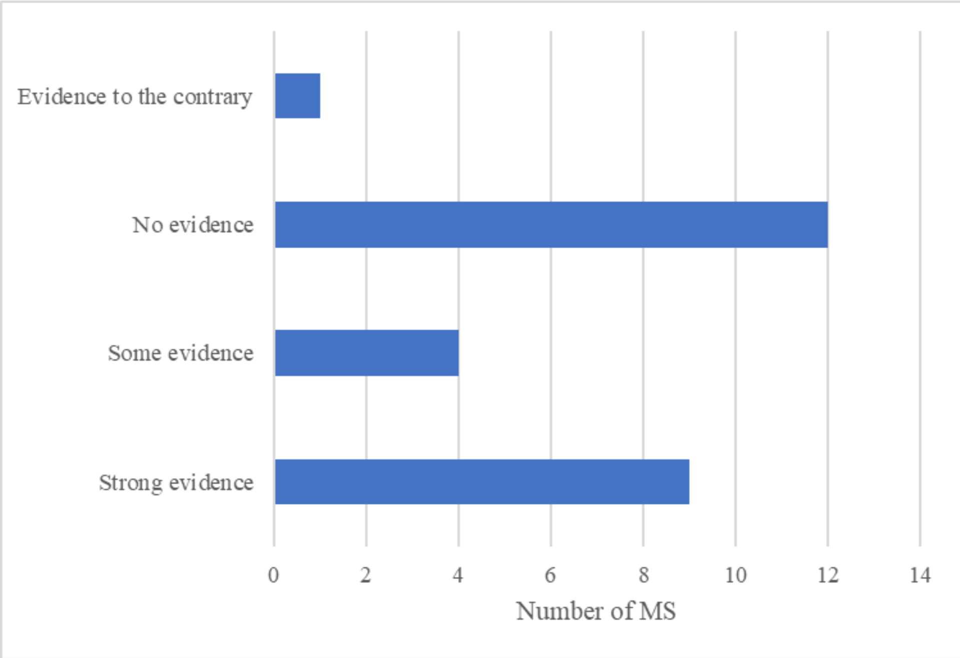
the Member States presented some or strong evidence of having made this distinction. The other half presented either no evidence, or evidence to the contrary.

Figure 33: Number of Member States where there is strong, some, no evidence or evidence to the contrary[112] *of criteria to distinguish between present day/future floods and significant present day/future floods*



Member States have adopted different criteria to define significant floods, examples of the criteria used include:

- defining of areas with significant flood risk included areas where the consequences of flooding are in an order of magnitude that will be of national relevance (Denmark),
- those areas characterized by a large number of individual damage sites (Finland),
- or the number of affected inhabitants, victims, risk perception, economic damage SEVESO sites, nature and ecology (in hectares), vital infrastructure and drinking water, cultural sites (the Netherlands).

To appreciate whether Member States differentiate between significant risk **presently** in an APSFR as opposed to significant **future** risk (due to the conditions influencing the risk having evolved-long term developments) an assessment of whether criteria to distinguish between significant flood risk existing **presently** in an APSFR are in place and whether criteria to distinguish between significant flood risk likely to arise **in the future** in an APSFR was made for each Member States. The results are shown in Figure 34. This shows that nearly half of the Member States presented strong evidence of criteria being in place to distinguish between significant flood risk existing presently in an APSFR, and slightly over a quarter of the Member States presented some evidence. However, almost three out of 10 (seven Member States) presented no evidence of such criteria being in place. Slightly less than one in five Member States[113] presented strong evidence of criteria being in place

[112] Evidence to the contrary: An explicit statement was found in the reporting stating that this criterion was not pursued.
[113] HR, HU, IE, LT and the NL.

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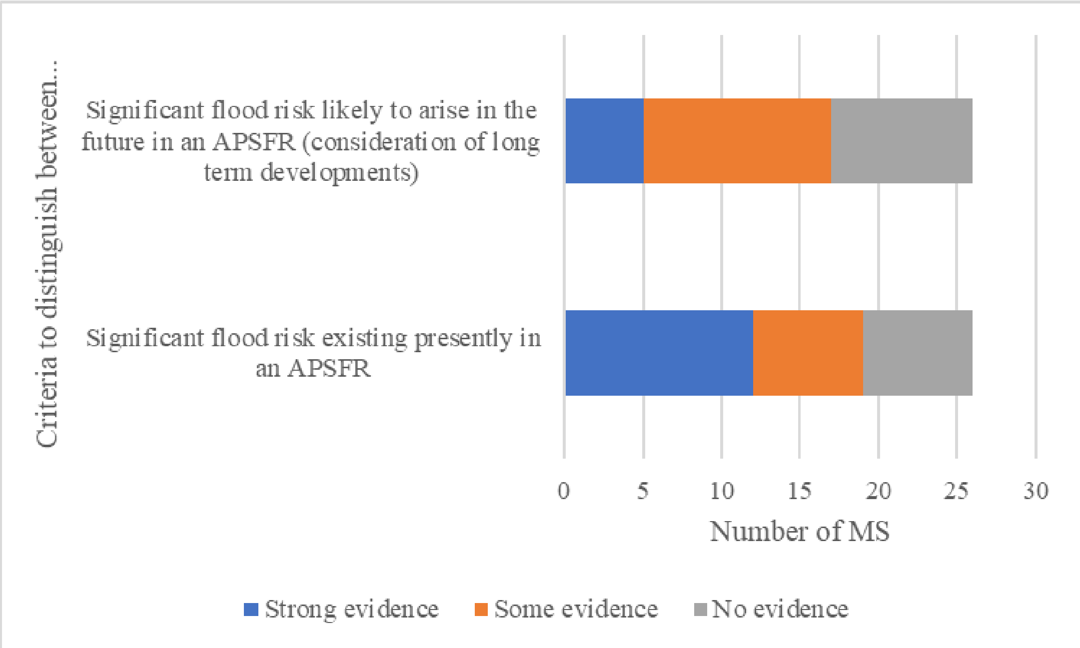
to distinguish between significant flood risk likely to arise in the future in an APSFR. However, a further 12 presented some evidence that criteria were in place but it was not clear from the documents provided how the criteria have either been derived, or how they are applied. Nine, or slightly over a third of Member States, provided no evidence of criteria being in place.

*Figure 34: Number of Member States where there is strong, some, or no evidence of criteria to distinguish between significant flood risk existing **presently** in an APSFR and criteria to distinguish between significant flood risk likely to arise **in the future** in an APSFR*



As part of their methodology for the designation of APSFRs, Member States should specify the criteria used for the determination of present or future significant flood risk as part of their approach to designating APSFRs.

Figure 35 shows the criteria used for the determination of significant flood risk in the selection of APSFRs and the number of UoMs that have used them. The number of permanent residents affected by the flood event has been used by slightly over four fifths of the UoMs, adverse consequences to economic activity has been used by slightly under four fifths of the UoMs and adverse consequences to infrastructure assets has been used in slightly over seven out of 10 UoMs. Adverse impacts on cultural assets and cultural landscapes was also used by 70% of UoMs.

Figure 36 shows the criterion used by UoMs for the selection of an area for inclusion in an APSFR. This shows that magnitude of risk to human health (slightly over three quarters of UoMs) magnitude of risk to economic activity (slightly under three quarters of UoMs), magnitude of risk to the environment (slightly under two thirds of UoMs) and magnitude of risk to cultural heritage (also slightly under two thirds of UoMs) were the most used criteria.

Most Member States used more than one criteria as shown in Figure 37, although not all criteria were used in all UoMs. For example, 16 criteria were used by UoMs in Italy, but only four criteria were used by all the UoMs for which information was provided. Similarly in Spain, 16 criteria were used but none were used by all UoMs and some (in agreement with neighbouring countries and high level of damage expected) were only used by one

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UoM. Two Member States used only one criterion. Estonia used exceedance of thresholds under specific weighting systems defined to assess significance and Lithuania reported that they used expert judgement.

Several Member States provided detailed information on the methodology used for the selection of APSFRs. For example, in the Po river basin in Italy reference was made to a specific document[114] laying out the methodology in detail including a flow chart summarising the process that was undertaken[115] and formulae for the calculation of the criteria used in the selection. Austria identified criteria and thresholds for the selection of APSFRs[116]. In Hungary, it is considered that “there is no difference between significant flood risk and the acceptable level of flood risk” and therefore, all areas covered by a 1:1000 year flood were identified as an APSFR regardless of the potential consequences of the flooding.

An assessment of the evidence of the criteria described above being considered was made for each Member State, and the results are shown in Figure 38. This shows that almost two thirds of Member States provided strong evidence of criteria being in place, whilst the remaining Member States provided some evidence of criteria but in many cases detailed information on how they had been derived and/or applied was lacking.

6.2. APSFR selection– developments since the previous cycle

The first cycle EU overview document found that some Member States gave detailed descriptions of their method including a number of steps whilst others mentioned criteria but did not indicate which methods were used to identify APSFRs. Some Member States did not provide any information at all on the criteria used. The guidance for reporting to the EIONET CDR has changed between the first and second cycle, and the Member States now report more information so a more complete overview of the situation in the Member States can be provided. All Member States have developed criteria for the identification of areas as an APSFR, although the evidence for how these have been derived and/or applied could be strengthened in some cases. Evidence for the criteria used for the determination of present or future significant flood risk as part of the approach to designating APSFRs is not clear in many cases, this appears to be similar to the first cycle.

[114] http://www.adbpo.it/PDGA_Documenti_Piano/PGRA2015/Sezione_A/Allegati/Allegato_3/Allegato_3_Relazione_ordinamento_e_gerarchizzazione_aree_a_rsichio.pdf

[115] See Case Study 24 at the end of this document.

[116] See Case Study 25

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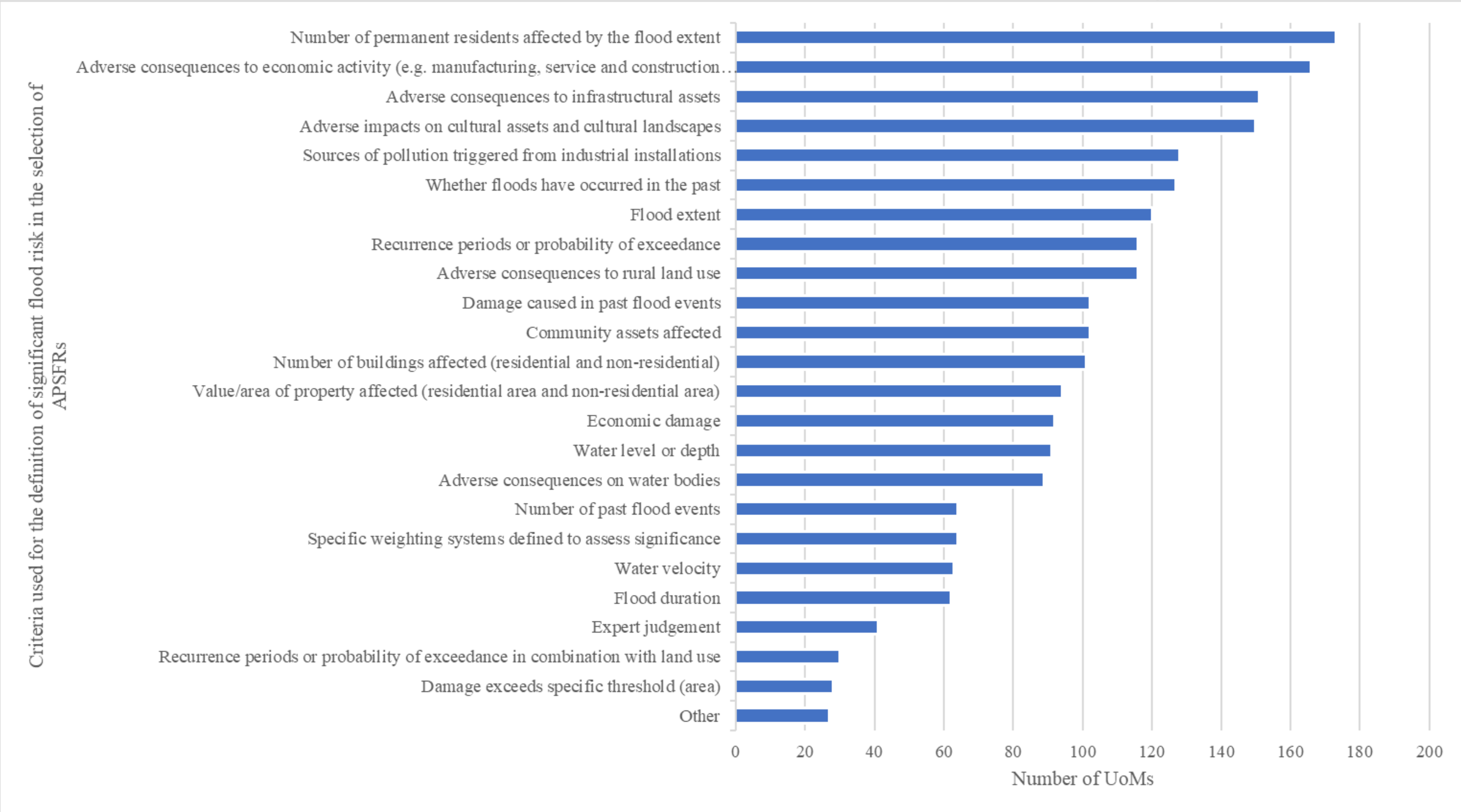
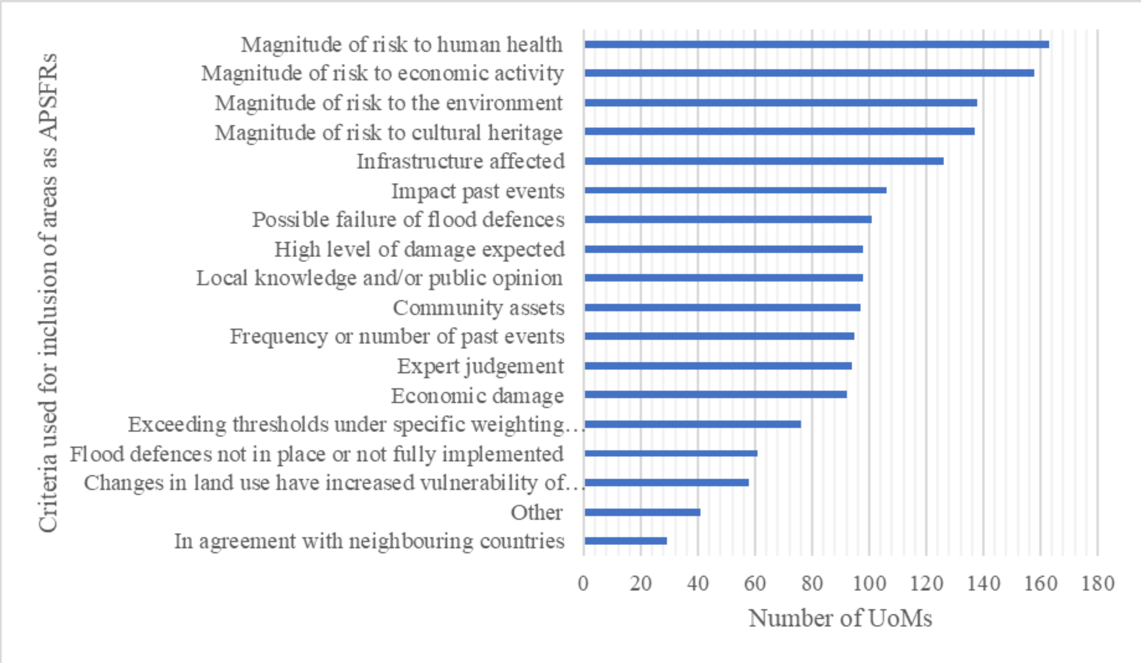
Figure 35: Criteria used for the determination of significant flood risk in the selection of APSFRs as reported to the EIONET CDR in the second cycle



Note: More than one criteria may be applied.

Figure 36: Criteria used for the inclusion of an area as an APSFR as reported to the EIONET CDR in the second cycle



Note: More than one criteria may be applied.

Figure 37 Number of criteria used by each Member States for the inclusion of an area as an APSFR as reported to the EIONET CDR in the second cycle

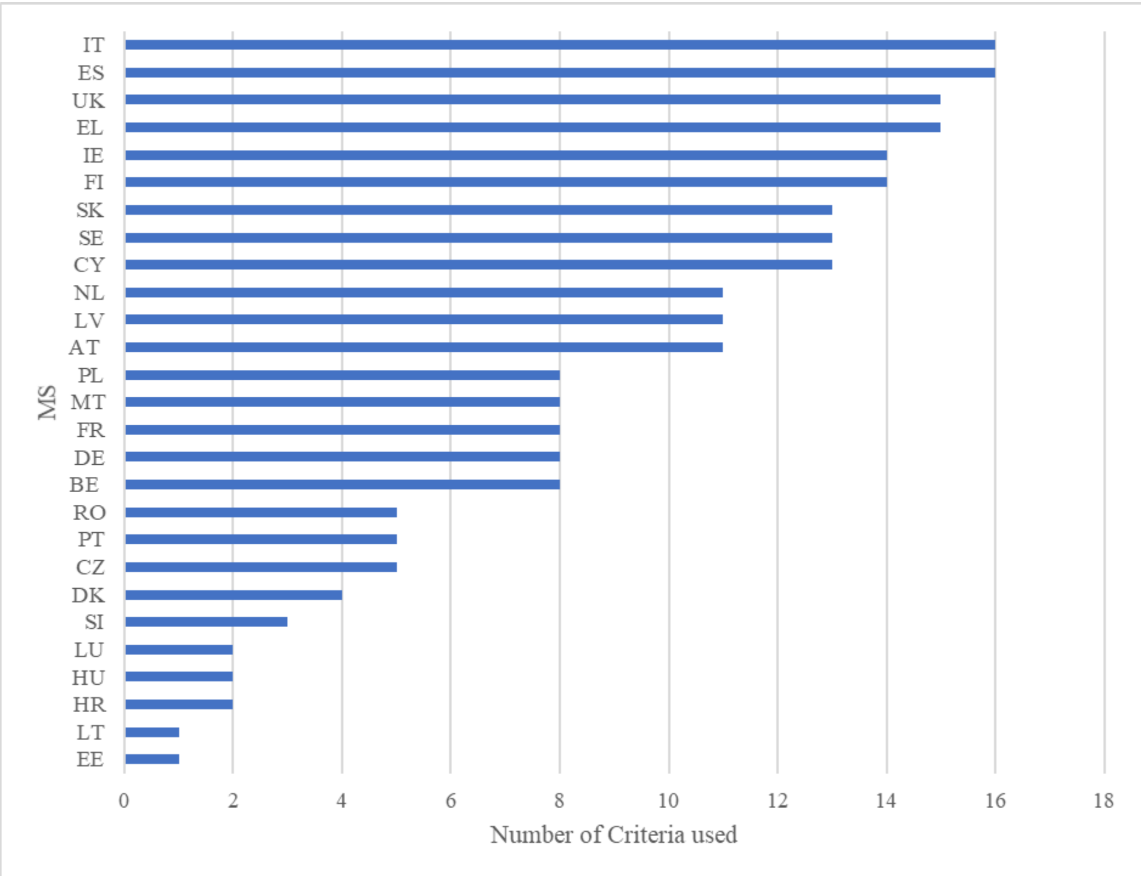


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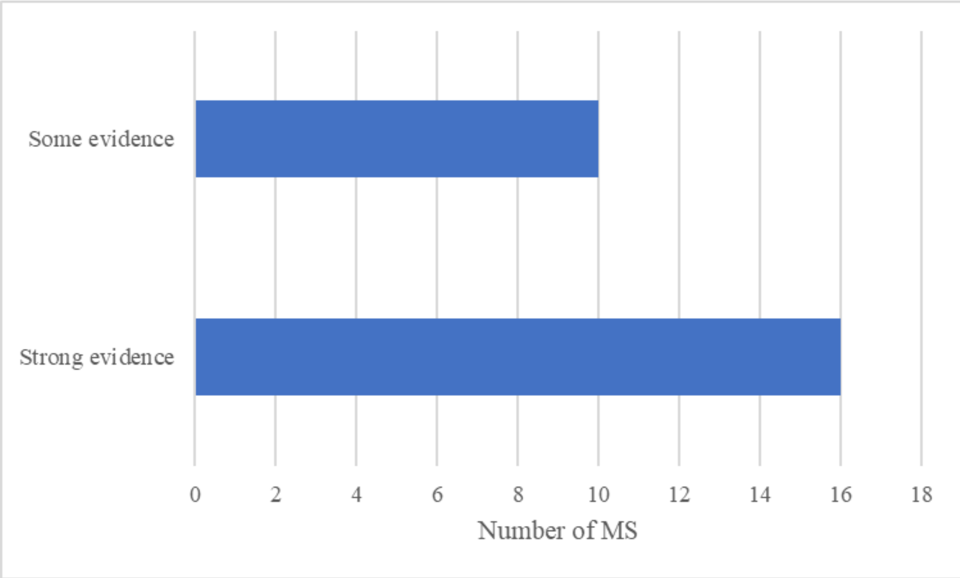
Figure 38: Number of Member States where there is strong evidence or some evidence of criteria relating to how human health, the environment, cultural heritage and economic activity being considered in the inclusion of APSFRs



6.3. Number of APSFRS and changes to APSFRs since the previous reporting

A total of 14 374 APSFRs have been reported, 274 of which are transboundary[117]. The number of APSFRs identified by each Member States is shown in Figure 39 (total APSFRs in parenthesis). In the first cycle a total of 4 549 APSFRs were reported[118], with four Member States applying Article 13.1(b) (Belgium, Italy, the Netherlands and Portugal) and one Member State (Malta) reporting no APSFRs. In the second cycle Italy and Croatia together have identified over half of the APSFRs in the EU[119].

Member States were asked to report how the APSFRs changed between the first and second cycles; this information is shown in Figure 40 Italy and Lithuania did not report data explaining the changes. Figure 41 shows the changes in APSFRs since first cycle for EU totals.

This shows that at an EU level, 4 808 APSFRs have not changed, 2 956 have been created, and 918 have been deleted. The code of 602 APSFRs has changed, but no change has been made to the geographic area covered. One likely explanation of the relatively high number of changes amongst APSFRs is that the identification of APSFRs is a process that has not settled (and will never entirely due to the changing nature of the risk). This ought not be considered as unusual since this is just the first update of APSFRs (APSFRs under the FD were first identified in 2011).

[117] The existence of transboundary APSFRs was not recorded in the first cycle's EU overview document.
[118] The UK excluded.
[119] Italy 3 799 APSFRs (slightly over a quarter) and Croatia 3 685 APSFRs (also slightly over a quarter).

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Figure 39: Total Number of APSFRs designated as reported to the EIONET CDR in the second cycle

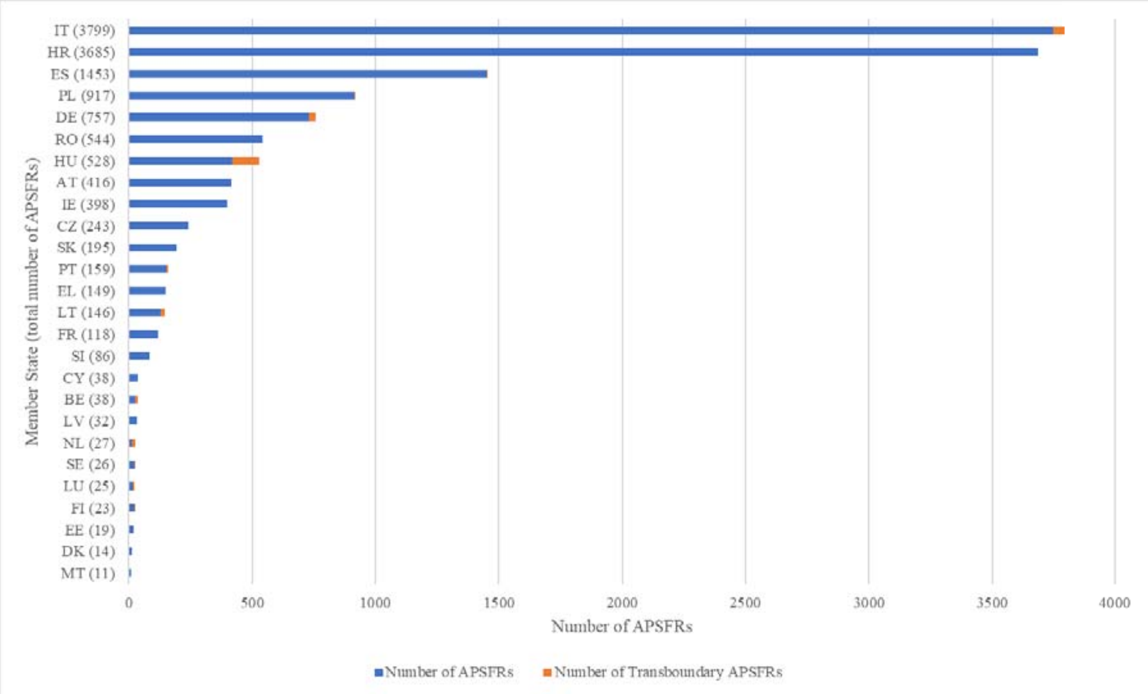
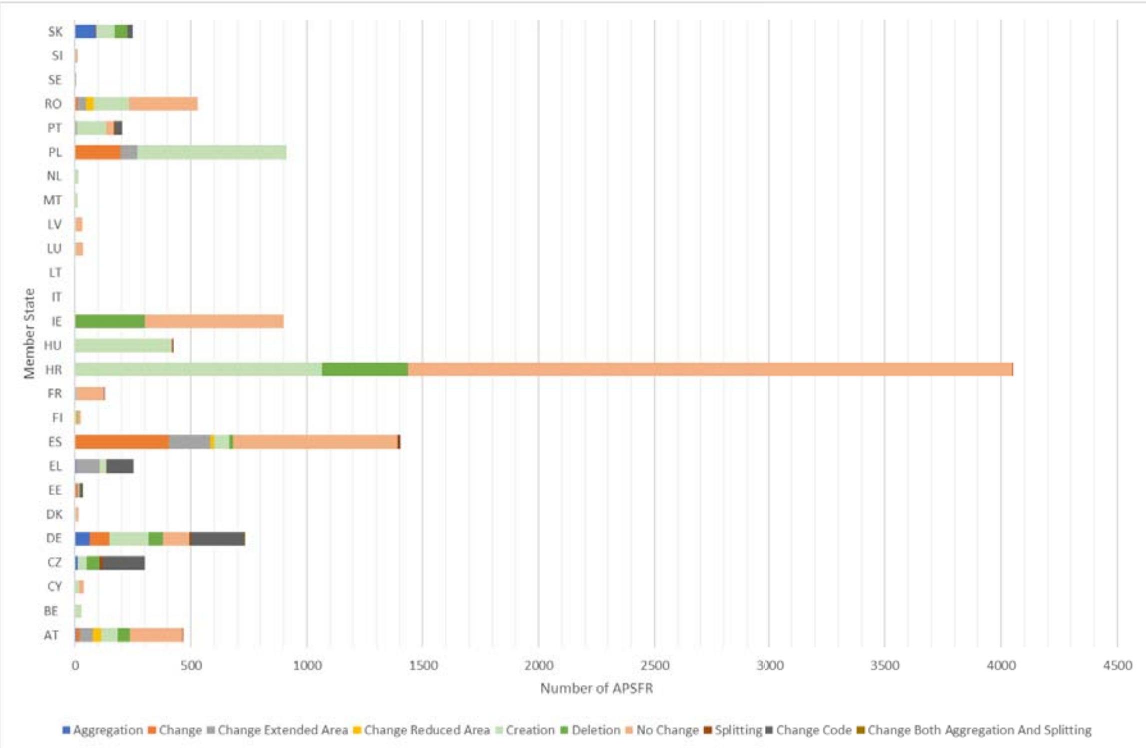


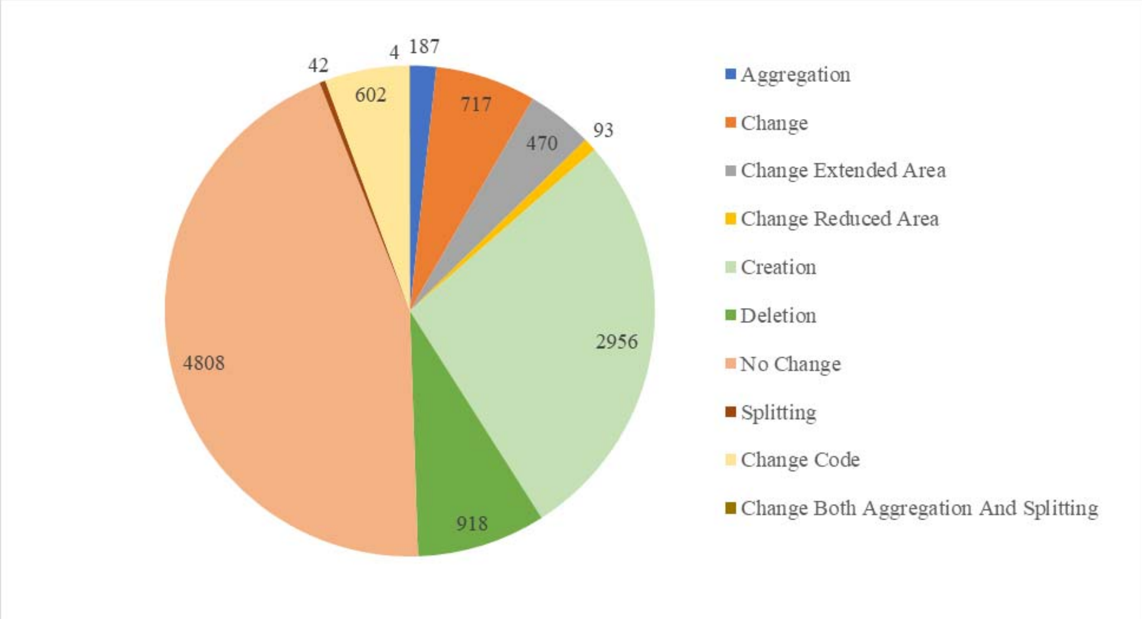
Figure 40: Changes in APSFRs since the first cycle (by Member State) as reported to the EIONET CDR in the second cycle



Notes:

- 'Change' refers to a slight modification, for example a minor adjustment to the geometry or resolution of an existing APSFR that does not fit under any of the other categories.
- Italy and Lithuania did not report data explaining the changes.

Figure 41 Changes in APSFRs since first cycle (total EU) as reported to the EIONET CDR in the second cycle



Note: 'Change' refers to a slight modification, for example a minor adjustment to the geometry or resolution of an existing APSFR that does not fit under any of the other categories.

6.4. Sources, mechanisms and characteristics of floods in ASPFRs

Data on the sources, mechanisms and characteristics of floods within the APSFRs are shown in Figure 42, Figure 43 and Figure 44 respectively. A source of flooding was identified for all APSFRs with the main source of flooding identified is fluvial (slightly more than 7 out of every ten APSFRs). The main mechanism being natural exceedance (slightly under one third of APSFRs), followed by natural exceedance in combination with defence exceedance (13% of APSFRs). No data[120] on the mechanisms was reported for nearly one out of every 10 APSFRs. It was reported that no data was available on the characteristics of flooding in 12% of APSFRs, but the most frequent characteristic reported was medium onset flood (slightly below one out of every 10 APSFRs), followed by debris flow (7%) and flash flood (4%).

Table 11 presents a comparison of the Member States that reported data on the source, mechanisms and characteristics of predicted future flood events, with the source mechanisms and characteristics of predicted flooding in APSFRs. It is clear from this, that Member States are more concerned about predicting the types of flood that will occur in an APSFR than for a predicted future flood event (not all of which may be significant).

The sources, mechanisms and characteristics of flooding in APSFRs reported in the first cycle are shown in Figure 45. It should be noted that due to a change in the reporting guidance for the second cycle Member States were able to report more than one source, mechanism and characteristic. The main source of flooding has not changed with fluvial still being the predominant source. In the first cycle, groundwater was not identified as a source of flooding in any APSFR, but in the second cycle, groundwater has been identified as the source of flooding in some APSFRs, albeit a small number. In the first cycle "no

[120] No data is where a Member States has reported that there is "No data" on the mechanisms or characteristics of flooding in the APSFR. Not all Member States reported information on the mechanisms or characteristics of flooding in APSFRs so it is possible that this is understated.

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data" was identified for the source of flooding in a small number of APSFRs, but in the second cycle the source of flooding has been identified for all. Similarly, the main mechanisms of flooding has not changed, natural exceedance and defence exceedance were both identified as the main mechanisms in the first cycle. In the first cycle the main characteristic of flooding in APSFRs was identified to be flash flooding followed by medium onset flood and debris flow. These three characteristics continue to be the predominant characteristics, but with a lesser emphasis being placed on flash flooding. In the first cycle data on the mechanism or characteristics of flooding was not available for 8% of APSFRs. It could be considered that this situation has not changed significantly, however, it should be taken into account that significantly more APSFRs have been reported in the second cycle.

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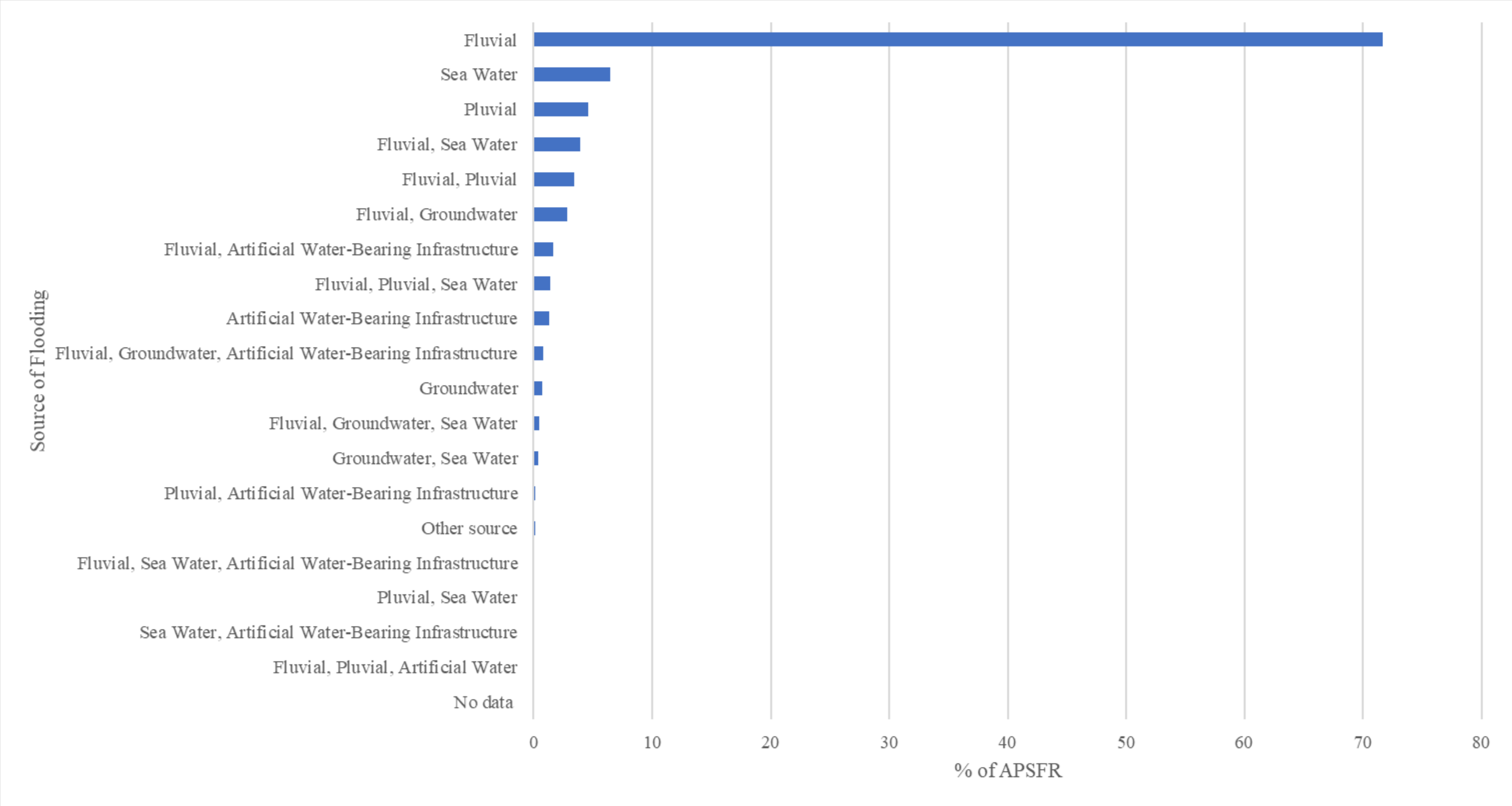
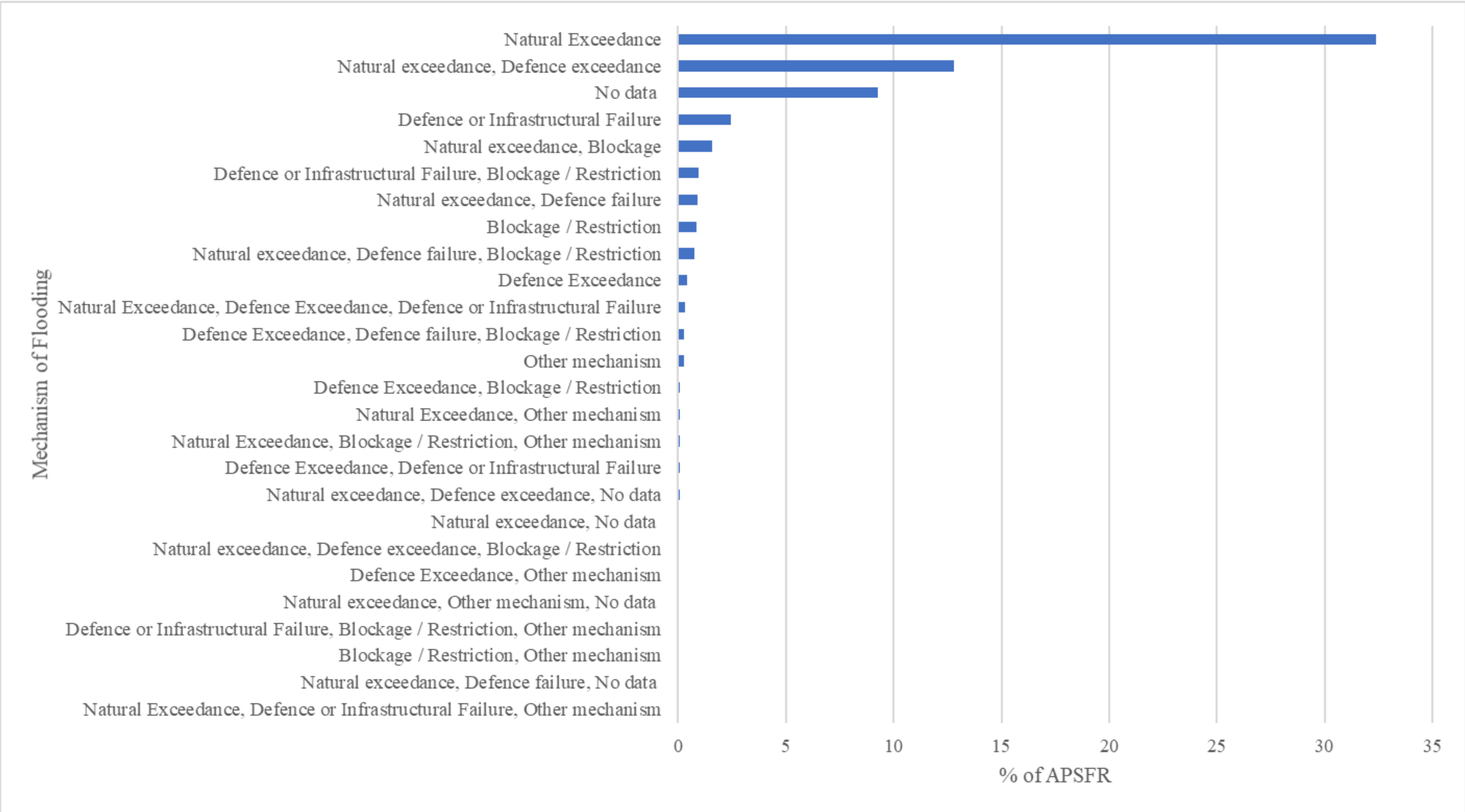
Figure 42: Sources of floods in APSFRs as reported to the EIONET CDR in the second cycle



Note: More than one source could be attributed to an APSFR.

Figure 43: Mechanisms of flooding in APSFRs as reported to the EIONET CDR in the second cycle



Note: No data is where a Member States has reported that there is "No data" on the mechanisms of flooding in the APSFR. Not all Member Statesreported this information. More than one mechanism could be selected per APSFR.

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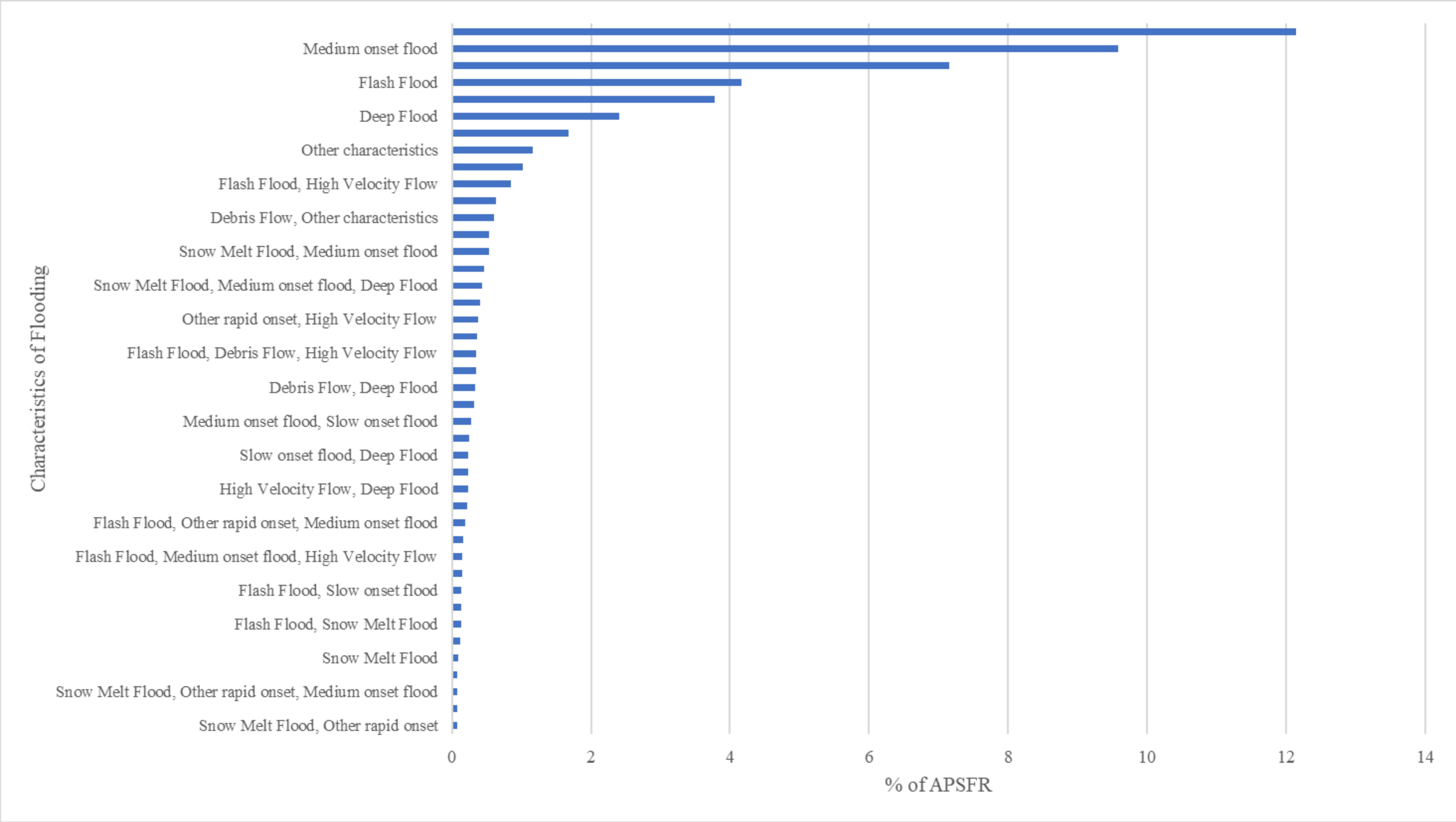
Figure 44: Characteristics of flooding in APSFRs as reported to the EIONET CDR in the second cycle



Note: No data is where a Member States has reported that there is “No data” on the mechanisms of flooding in the APSFR. Not all Member Statesreported this information. More than one characteristic could be selected per APSFR.

Table 11: Comparison of whether data has been reported by Member States on the source mechanism and characteristics of future floods, with whether data has been reported on the source, mechanism and characteristics of flooding in APSFRs

MS	Source, mechanism, and characteristics of future floods reported	Source mechanism and characteristics of flooding in APSFRs reported
AT	NO	YES
BE	YES	YES
BG	Did not report in time to be included	
CY	NO	YES
CZ	NO	YES
DE	YES	YES
DK	NO	YES
EE	YES	YES
EL	YES	NO
ES	YES	YES
FI	YES	YES
FR	NO	YES
HR	NO	YES
HU	NO	YES
IE	NO	YES
IT	YES	YES
LT	NO	YES
LU	YES	YES
LV	YES	YES
MT	YES	YES
NL	NO	YES
PL	YES	YES
PT	NO	YES
RO	YES	YES
SE	NO	YES
SI	NO	YES
SK	YES	YES

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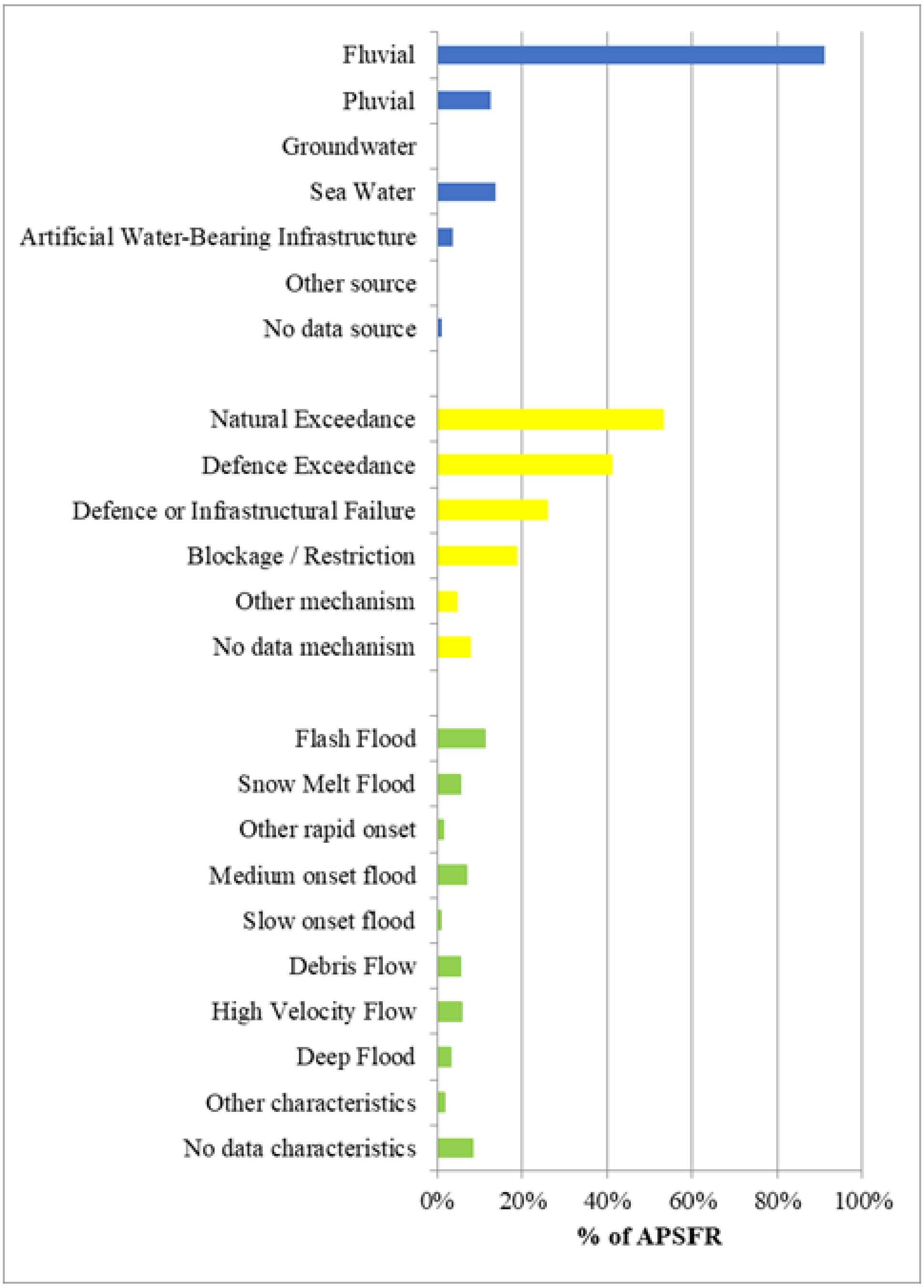
Figure 45: Sources, mechanisms and characteristics of flooding in APSFRs from the first cycle assessment



6.5. Adverse consequences associated with APSFRs

Figure 46 shows the consequences associated with APSFRs in the second cycle. 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 (also having environmental implications), and would include fatalities have been identified in a quarter of APSFRs whilst consequences for property (including homes) has been identified in 70% of APSFRs, consequences for rural land use in 61% of APSFRs and consequences for infrastructure in 59% of APSFRs. Adverse consequences to cultural heritage, which could include archaeological sites / monuments, architectural sites, museums, spiritual sites and buildings have been identified in a bit less than half of

APSFRs and adverse consequences for protected areas in also a bit less than half of APSFRs.

Figure 47 shows the adverse consequences associated with APSFRs in the first cycle. This shows that whilst consequences for human health and the economy continue to predominate in the second cycle, that a greater emphasis has been placed on consequences for cultural heritage, and particularly the environment.

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Figure 46: Consequences associated with APSFRs as reported to the EIONET CDR in the second cycle

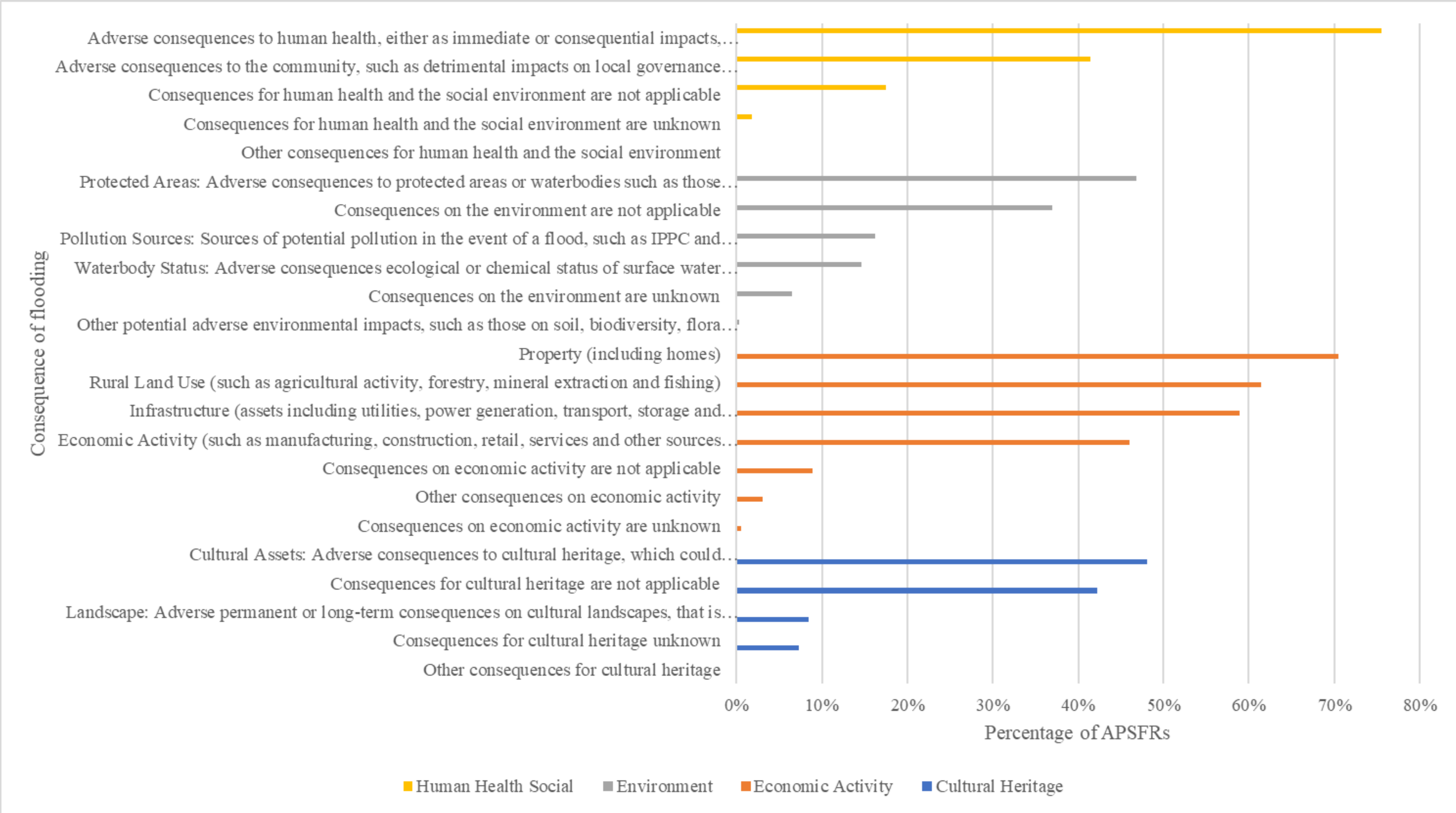
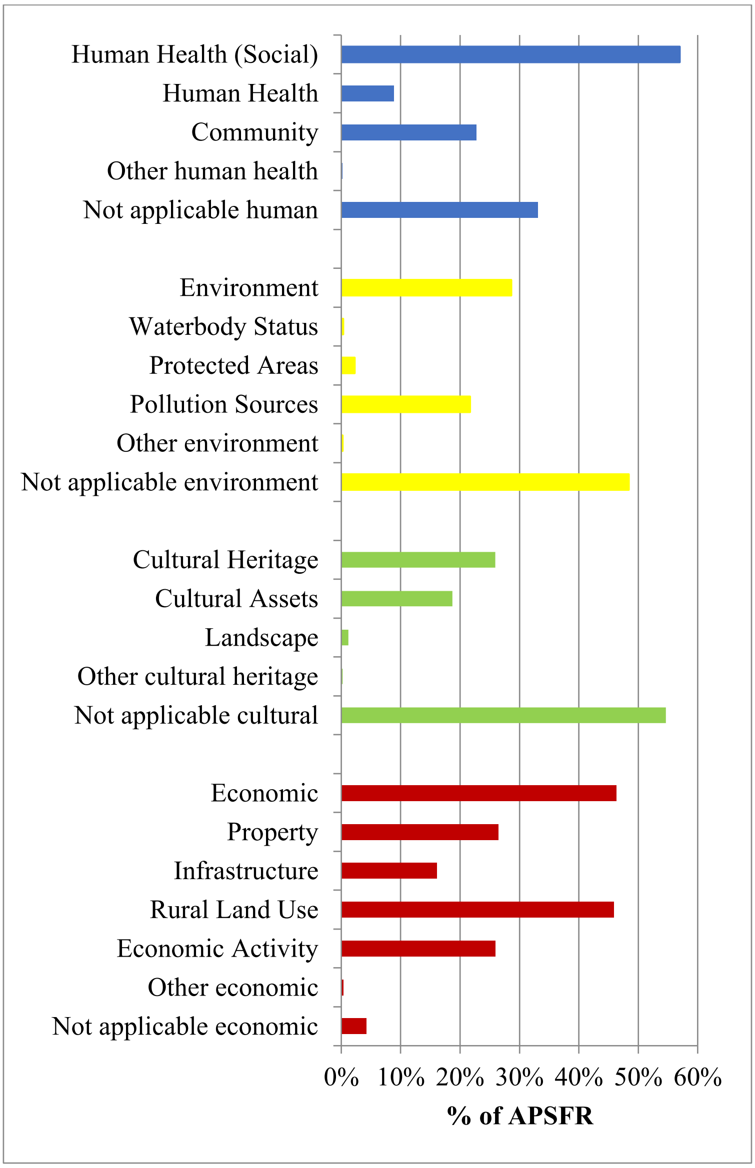


Figure 47: Consequences associated with APSFRs in the first cycle



7. Consideration of climate change

7.1. Evidence of consideration of climate change by the Member States

According to the 6th IPCC report[121], at 1.5°C global warming, heavy precipitation and associated flooding are projected to intensify and be more frequent in Europe (medium confidence), whereas at 2°C global warming and above heavy precipitation and associated flooding events are projected to become more intense and frequent in Europe (medium to high confidence).

Article 14 of the FD requires reviews and updates of each of the three flood risk management steps of the Directive to be provided and specifically requests that the impact of climate change on the occurrence of floods is taken into account as part of the review process of PFRAs and FRMPs. Figure 48 shows the number of Member States where the

[121] https://www.ipcc.ch/assessment-report/ar6/

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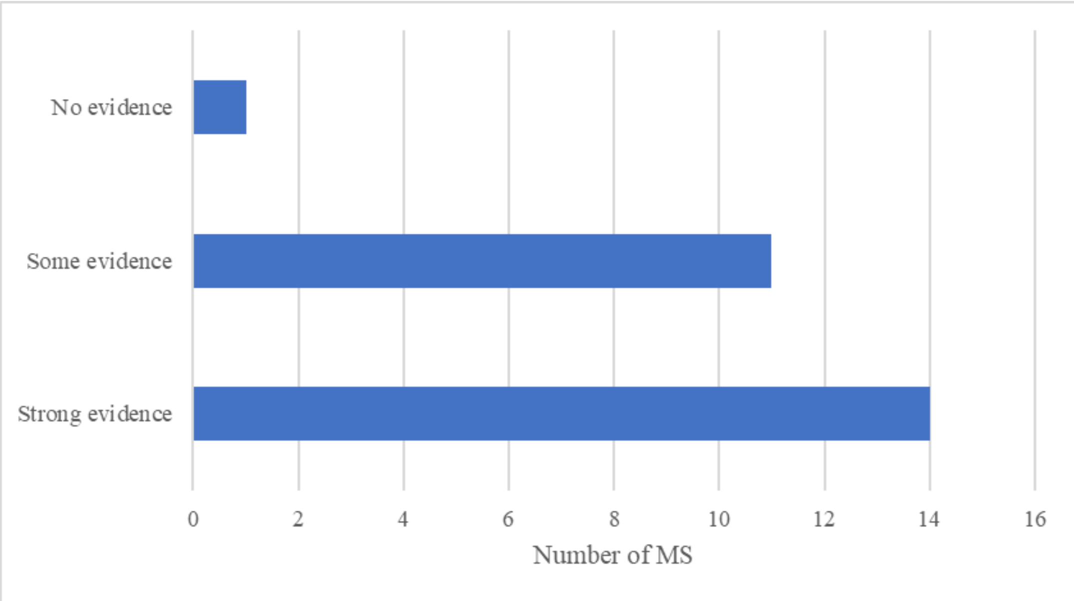
results of the Commission's assessments indicate whether there is strong evidence, some evidence, or no evidence of a focus on the consideration of the likely impact of climate change on floods in the Member States' PFRA. This shows that only one Member State (Luxembourg) did not report any evidence of the impact of climate change[122], whilst over half of the Member States presented strong evidence that the impact of climate change on flooding had been considered[123].

Figure 48: Number of Member States where there is strong, some, or no evidence of a clear methodology being in place to consider climate change



Only four Member States[124] explicitly mention their national adaptation strategy. Seven Member States[125] mention the Intergovernmental Panel on Climate Change (IPCC) scenarios, although it is not clear from the information provided in all cases whether the findings have been used as the basis for future work. In the Netherlands, the IPCC scenarios has been used as the basis for a national programme on the impacts of climate change[126].

Five Member States explicitly state that they have used modelling studies to assess the impact of climate change on flood risk. Germany has used inland flood modelling to link global and regional climate models with water balance models[127], whilst in Croatia the State Hydrometeorological Institute carried out modelling studies[128]. Hungary has stated that it has participated in a number of pan-European modelling projects[129] modelling the effects of climate change. The outcomes of these studies have been incorporated into four

[122] Luxembourg subsequently provided relevant information.
[123] Already in the first cycle trends from the IPCC or national research programs were used, but it was mostly unclear how. Some countries provided more detailed information, such as Germany and Lithuania.
[124] HR, IT, NL and SI.
[125] CZ, DE, DK, IE, LV, NL and PT.
[126] See case study 26 at the end of this document.
[127] Germany referred to modelling, statistical assessment and scenario building already in the first cycle.
[128] See case study 27.
[129] Funded by EU Research Framework Programmes, including PRUDENCE1, ENSEMBLES, CECILIA, and CLAVIER.

domestic climate change models[130] which have been used for the assessment of the impact of climate change on flood risk. In Portugal the Institute of the Sea and the Atmosphere (IPMA) developed scenarios of climate change based on the result of climate models[131] whilst Sweden has used advanced and detailed modelling to incorporate climate change into its assessments[132].

Hungary was not the only Member State to build on the results of European funded projects. In Belgium, Wallonia used the results of the AMICE[133] project to assess climate change impacts in the basin of the Meuse.

In the first cycle, 16 Member States considered climate change in their assessments of flood risk. Seven did not and there was no information for the remaining five Member States. It is clear that in the second cycle Member States have given more consideration to the impact of climate change on floods with most Member States having carried out assessments. However, in many cases it is not clear from the evidence provided how the results of the studies conducted have been incorporated into the PFRA and/or been taken into consideration in the selection of APSFRs.

7.2. Development of the consideration of climate change in future PFRAs

The FD requires Member States to consider the possible impacts of climate change on the occurrence of floods when assessing and managing potential flood risks. However, in several Member States there is room to improve the way in which climate change is incorporated in PFRAs, FHRMs or FRMPs. This is because the effects of climate change on floods at the level of an APSFR represent a "local" response to a changing climate and Member States often find it challenging to directly interpret future changes in rainfall and river flows from continental or regional climate change projections of changes in precipitation.

During the 2018 European Court of Auditor's (ECA) audit of Member States' first cycle FRMPs[134], the audited Member States Member States emphasised challenges in relation to quantifying flood risk under future climate change, considering the large uncertainties present in the current climate change modelling frameworks. These large uncertainties were a factor that led to some Member States choosing either not to include climate change impacts in their first FRMPs, or to do so only in a limited manner.

In February 2021, a new EU Strategy on Adaptation to Climate Change was adopted by the European Commission[135]. The new strategy will support closing knowledge gaps on climate impacts and resilience, and the further development and implementation of adaptation strategies and plans at all levels of governance with three cross-cutting priorities:

- integrating adaptation into macro-fiscal policy;

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[130] ALADIN-Climate, PRECIS, RegCM and REMO.
[131] See case study 28.
[132] See case study 29.
[133] Adaptation de la Meuse aux Impacts des Evolutions du Climat (AMICE), INTERREG (2009-2013).
[134] https://www.eca.europa.eu/en/Pages/DocItem.aspx?did=47211
[135] https://ec.europa.eu/clima/eu-action/adaptation-climate-change/eu-adaptation-strategy_en

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- nature-based solutions for adaptation;
- local adaptation action.

Furthermore, the European Climate Law[136], adopted in July 2021, makes the goal set out in the European Green Deal[137] for Europe's economy and society to become climate-neutral by 2050 a binding target. As part of the Climate Law "*Member States will also be required to develop and implement adaptation strategies to strengthen resilience and reduce vulnerability to the effects of climate change*" (Article 5). Hence, Member States should develop and implement flood risk management measures and strategies that take into account climate change.

Datasets assessing the future flood risk in Europe under different climate change scenarios are available in the Climate Data Store of the Copernicus Climate Change Service[138] as well as from the PESETA IV[139] study of the Commission's Joint Research Center. These datasets can complement or support the efforts of Member States in the identification of future floods with potential adverse consequences at the national or regional level. Furthermore, the Copernicus Emergency Management Service[140] provides the possibility to strengthen early warning systems through its European Flood Awareness System, to support emergency response to future floods by its rapid mapping component and to assess floods risk through its Risk and Recovery Mapping component. All these tools aim at complementing the efforts of Member States to adapt to changes in future flood risk under a changing climate.

A new technical guidance on climate-proofing of infrastructure projects for the period 2021-2027[141], published in September 2021, will further support Member States in mainstreaming climate considerations in future investment and development of infrastructure projects, including floods related infrastructure.

Based on a survey of Member States discussing the impact of climate change on floods[142], a number points should be considered for the third cycle of the FD, particularly:

- There is a need for improved interaction between scientific research and practice, including decision and policy makers from the local to the national scale.
- A risk-based approach seems to be an appropriate tool to deal with uncertainty in climate change projections.
- Improved use of data sets already available from the Copernicus Climate Data Store[143] that is part of the Copernicus Climate Change Service[144].

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136 https://ec.europa.eu/clima/eu-action/european-green-deal/european-climate-law_en
137 https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en
138 https://cds.climate.copernicus.eu/#!/home
139 https://ec.europa.eu/jrc/en/peseta-iv
140 https://emergency.copernicus.eu/
141 https://op.europa.eu/en/publication-detail/-/publication/23a24b21-16d0-11ec-b4fe-01aa75ed71a1/language-en
142 Published as part of the 6th Implementation Report package,https://ec.europa.eu/environment/water/water-framework/impl_reports.htm
143 https://cds.climate.copernicus.eu/#!/home
144 https://climate.copernicus.eu/

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- Further development of knowledge and online tools, potentially at European level (such as ClimateADAPT[145]), to provide input data useful to hydrological modelling, for example, increases in rainfall intensity and flood flows under a range of climate change scenarios.

The next CIS work programme for the period 2022-2024[146] provides an opportunity to further intensify the work on climate change and flood risk management[147].

145 https://climate-adapt.eea.europa.eu/

146 https://circabc.europa.eu/ui/group/9ab5926d-bed4-4322-9aa7-9964bbe8312d/library/3644e20b-f5c5-46de-9d2f-3d9efb965fac?p=1&n=10&sort=modified_DESC and https://circabc.europa.eu/ui/group/9ab5926d-bed4-4322-9aa7-9964bbe8312d/library/dd9b4484-2935-4ee8-b3ce-72f844f3644c?p=1&n=10&sort=modified_DESC

147 The CIS Working Group Floods can serve as platform to exchange on best practice and research projects, https://circabc.europa.eu/ui/group/9ab5926d-bed4-4322-9aa7-9964bbe8312d/library/9560db96-04c6-4377-bf82-84766955e54a?fromLink=true

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EUROPEAN
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Brussels, 15.12.2021
SWD(2021) 971 final

PART 2/2

COMMISSION STAFF WORKING DOCUMENT

European Overview- 2nd Preliminary Flood Risk Assessments

Accompanying the document

REPORT FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL

on the implementation of the Water Framework Directive (2000/60/EC), the Environmental Quality Standards Directive (2008/105/EC amended by Directive 2013/39/EU) and the Floods Directive (2007/60/EC)

Implementation of planned Programmes of Measures
New Priority Substances
Preliminary Flood Risk Assessments and Areas of Potential Significant Flood Risk

{COM(2021) 970 final} - {SWD(2021) 970 final}

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8 Transboundary co-operation

8.1 Information exchange and types of transboundary cooperation

In their reporting for the second cycle, Member States are required to provide information on the methodology for international information exchange relating to PFRAs and APSFRs that cross international boundaries. Article 4.3 of the FD states where international river basin districts or units of management exist which are shared with other Member States, exchange of relevant information relating to the undertaking of PFRAs shall be ensured between the Competent Authorities concerned. Further to information exchange during the PFRA phase, where an APSFR belongs to an international River Basin District or UoM shared with another Member States, the designation of these areas shall be coordinated between the Member States concerned.

There are 75 international River Basin Districts in the EU. International coordination mechanisms (agreements, working groups etc.) vary among the different international river basin districts. Based on their level of cooperation, four main categories were identified. An overview of different types of international cooperation is given in Table 12 below[1].

Table 12: Different categories of international coordination

Category	Formal international agreement	International coordinating body	iRBMP produced
1	Yes	Yes	Yes
2	Yes	Yes	No
3	Yes	No	No
4	No	No	No

The international RBDs/UoMs are shown in Figure 49.

Member States were asked to report the mechanisms used for international cooperation and collaboration for the preparation of the PFRA (Figure 50) and in the designation of APSFRs (Figure 51). It should be noted that Member States are only required to report on the latter where transboundary APSFRs have been identified. It is clear that the International River Basin Commissions have an important role to play in co-ordinating the preparation of the PFRAs in international RBDs. However, when it comes to the designation of APSFRs bilateral co-operation seems to be the primary mechanism to ensure coordination.

[1] The table and map are for illustration only. The categories of the iRBDs were taken from the assessment of international coordination in the first cycle of the WFD. See: Vogel, B., et al. (2012): Transboundary Cooperation Fact Sheets. Comparative Study of Pressures and Measures in the Major River Basin Management Plans. available at: http://ec.europa.eu/environment/archives/water/implrep2007/pdf/Governance-Transboundary%20Fact%20Sheets.pdf
The circumstance in the River Commissions or the situation in the Member States may have changed since then.

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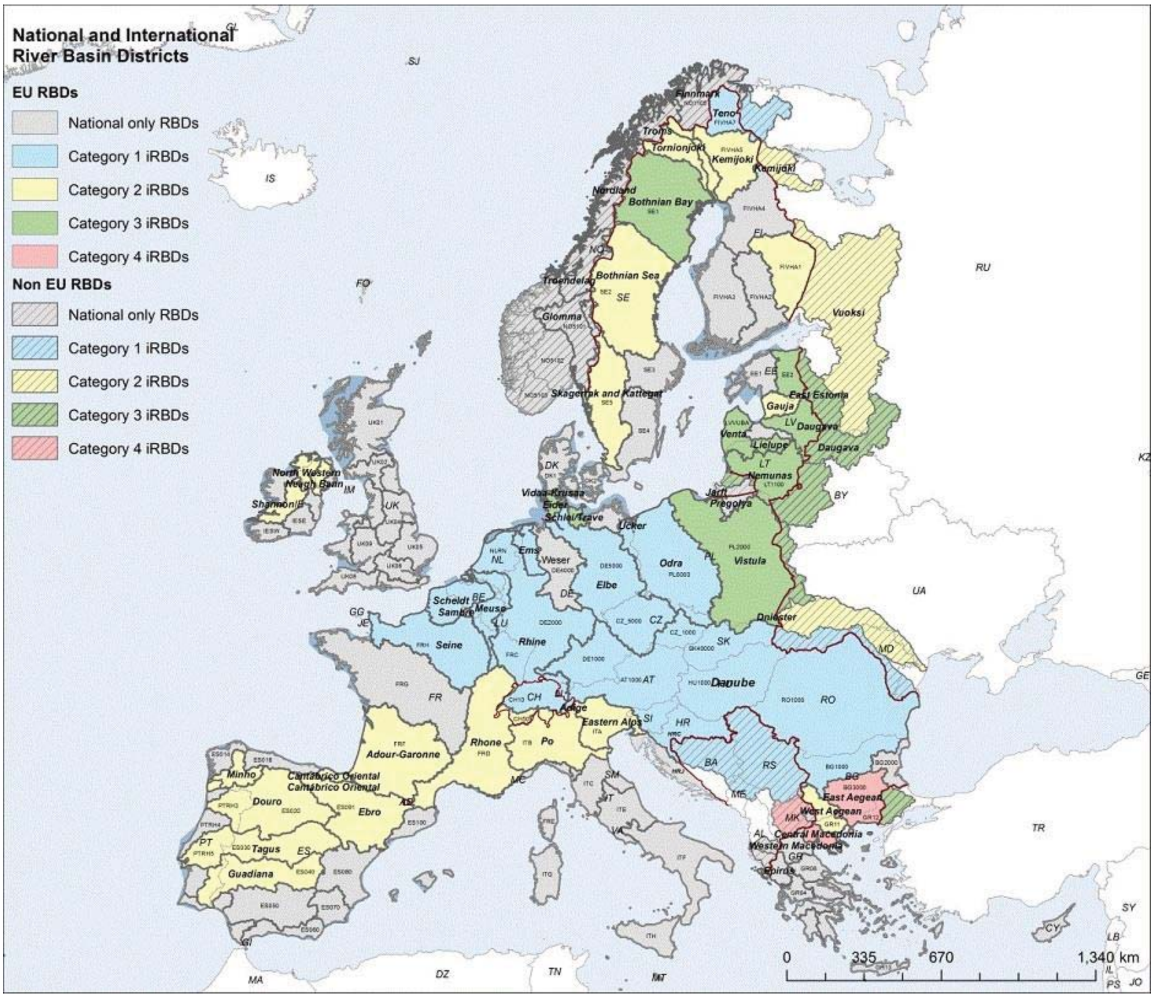
Figure 49: Map of International RBDs/UoMs



Member States were asked to provide supporting information detailing the co-ordination mechanisms that are in place. An assessment has been made of whether it can be verified that international information exchange has taken place between Member States in the case of international RBDs or UoMs with a clear description of the methodology provided.

Table 13 shows which Member States provided strong evidence, some evidence or no evidence to support their claims, and Figure 52 shows the same information summarised in a chart. It can clearly be seen that most Member States presented some supporting evidence, but in a number of cases this information could have been stronger, particularly in relation to bilateral co-operation in the designation of APSFRs.

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Figure 50: How information is exchanged in UoMs for the preparation of the PFRA as reported to the EIONET CDR in the second cycle

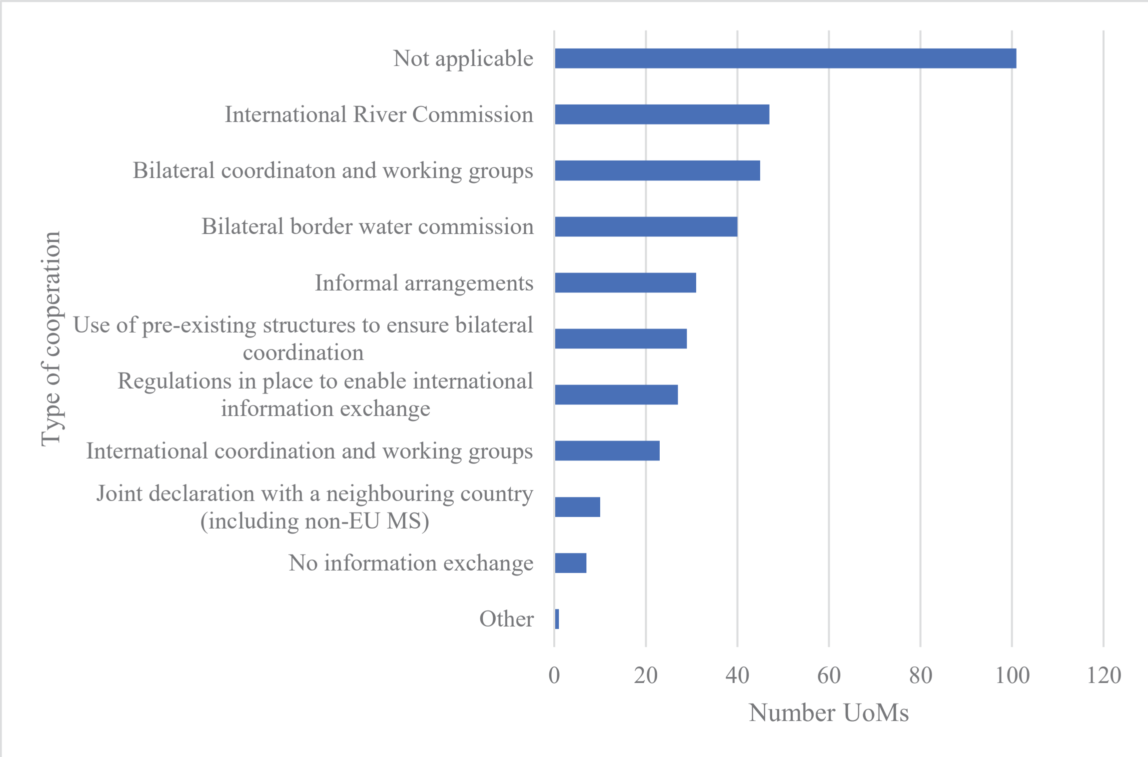

Figure 51: Type of cooperation in the identification of APSFRs as reported to the EIONET CDR in the second cycle

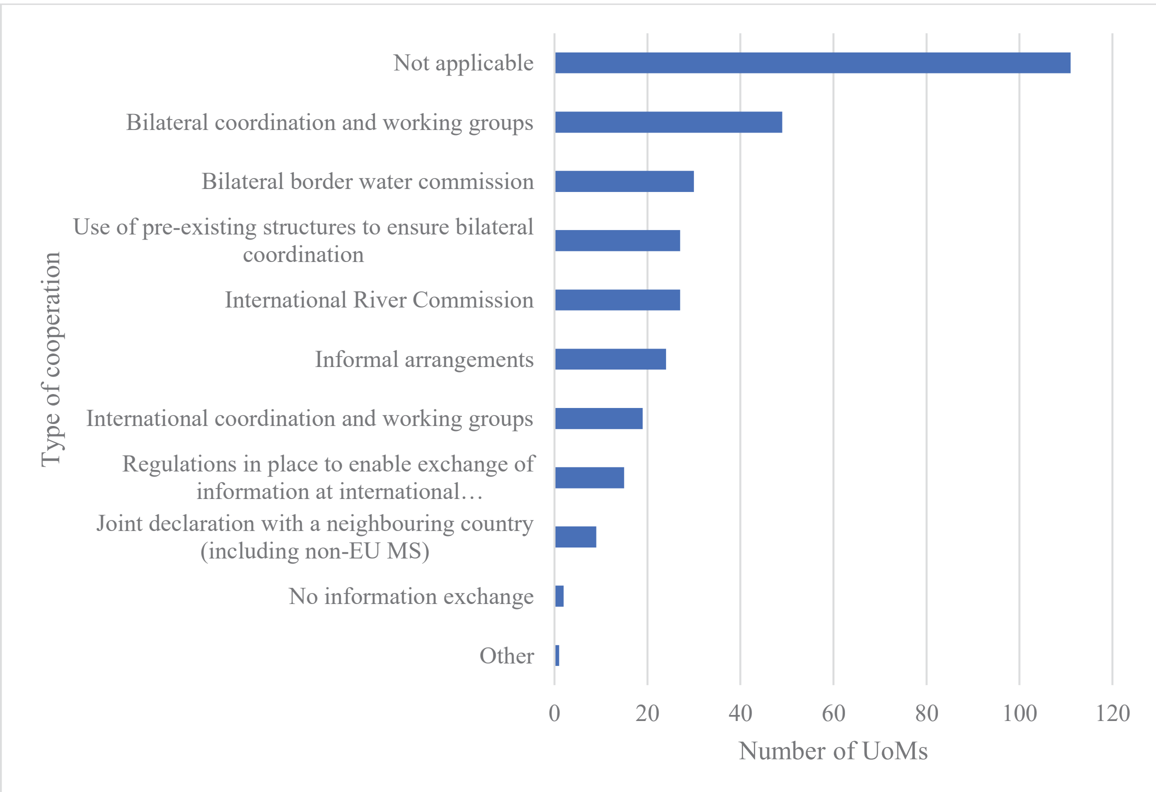

Table 13: Evidence presented to support whether information exchange has taken place, or not

MS	Information exchange has taken place during the PFRA assessment	APSFR methodology assessment
AT	Strong evidence	Some evidence
BG	Did not report in time for the Commission's assessment	
BE	Strong evidence	Some evidence
CY	No transboundary UoMs	No transboundary UoMs
CZ	Strong evidence	Some evidence
DE	Strong evidence	Some evidence
DK	Data not reported	No transboundary APSFRs
EE	Some evidence	Some evidence
EL	Some evidence	Data not reported
ES	Some evidence	Strong evidence
FI	Strong evidence	Strong evidence
FR	Some evidence	Strong evidence
HR	Strong evidence	Strong evidence
HU	Strong evidence	Strong evidence
IE	Strong evidence	Strong evidence
IT	Some evidence	Some evidence
LT	Some evidence	Some evidence
LU	Strong evidence	Strong evidence
LV	Strong evidence	Some evidence
MT	No transboundary UoMs	No transboundary UoMs
NL	Strong evidence	Strong evidence
PL	Strong evidence	Some evidence
PT	Strong evidence	Some evidence
RO	Strong evidence	Strong evidence
SE	Strong evidence	Strong evidence
SI	Strong evidence	Strong evidence
SK	Some evidence	Data not reported

Key:

Strong evidence
Some evidence
Not applicable
Data not reported

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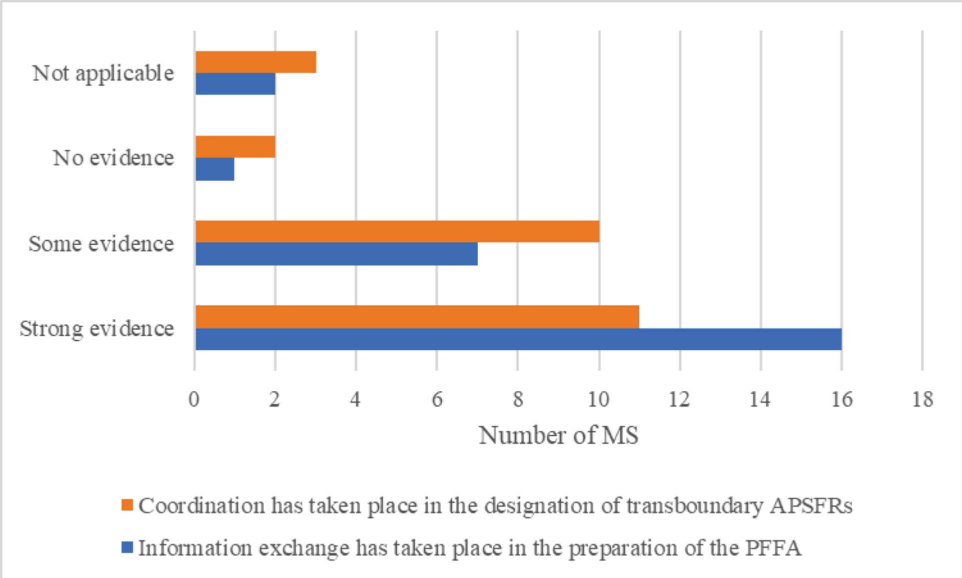
Figure 52: The evidence presented to support whether information exchange has taken place, or not



In order to confirm whether co-ordination is taking place at a bilateral level, some transboundary UoM's were selected and the data on the designation of APSFRs and the mechanism of co-operation reported was compared (Table 14). This showed inconsistencies between UoMs where the information reported would be expected to be the same. For example, in the Nemunas international UoM shared between Lithuania and Poland, Lithuania has reported nine transboundary APSFRs, but Poland has reported none. Whilst both Member States have reported that a bilateral border water commission is in place, Lithuania has also reported that bilateral working groups and the use of pre-existing structures (in place before the FD was adopted) to ensure bilateral co-operation. Similarly, in the Guadiana UoM shared between Spain and Portugal, Spain has reported no transboundary APSFRs, but Portugal has reported two. Both have reported that bilateral working groups are in place to ensure coordination, but Spain has reported that a bilateral border water commission is in place, which Portugal has not reported. On the other hand, Portugal has reported that regulations are in place to ensure bilateral co-operation. In the Danube international UoM, most of the Member States who are part of the International River Commission have reported no transboundary APSFRs (AT, DE, RO, CZ, SK). However, Hungary, has reported 109 cross-border APSFRs. It is therefore not clear whether these have been agreed with the other Danube countries.

The majority of these inconsistencies is likely a matter of neighbouring Member States coordinating better ahead of reporting to the Commission than symptoms of failing cooperation. However, the designation or not of cross-border APSFRs is an aspect that merits attention from the part of Member States and an area where synergies could be achieved, e.g. in the case of measures (and their funding) that have benefits extending beyond borders.

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Table 14: Comparison of international coordination and number of transboundary APSFRs in selected international UoMs

International UoM	National UoM (MS)	Reported means of achieving coordination in preparation of PFRA	Number Cross-border APSFRs reported	Reported means of achieving coordination in designation of APSFR reported
Venta	LVVUBA (LV)	Informal arrangements (groups discussions and exchange of information)	0	Informal arrangements (groups discussions and exchange of information)
	LT2300 (LT)	Bilateral border water commissions Bilateral coordination and working groups Use of pre-existing structures to ensure bilateral coordination Informal arrangements (groups discussions and exchange of information)	3	Bilateral border water commissions Bilateral coordination and working groups Use of pre-existing structures to ensure bilateral coordination
Lielupe	LVLUBA (LV)	Joint declaration with a neighbouring country (including non-EU Member States) on cooperation on joint action	0	Joint declaration with a neighbouring country (including non-EU Member States) on cooperation on joint action
	LT3400 (LT)	Bilateral border water commissions Bilateral coordination and working groups Use of pre-existing structures to ensure bilateral coordination Informal arrangements (groups discussions and exchange of information)	3	Bilateral border water commissions Bilateral coordination and working groups Use of pre-existing structures to ensure bilateral coordination
Dauguva	LVDUBA (LV)	Joint declaration with a neighbouring country (including non-EU Member States) on cooperation on joint action	0	Joint declaration with a neighbouring country (including non-EU Member States) on cooperation on joint action
	LT4500 (LT)	Bilateral border water commissions Bilateral coordination and working groups Use of pre-existing structures to ensure bilateral coordination Informal arrangements (groups discussions and exchange of information)	2	Bilateral border water commissions Bilateral coordination and working groups Use of pre-existing structures to ensure bilateral coordination
Nemunas	LT1100 (LT)	Bilateral border water commissions Bilateral coordination and working groups Use of pre-existing structures to ensure bilateral coordination Informal arrangements (groups discussions and exchange of information)	9	Bilateral border water commissions Bilateral coordination and working groups Use of pre-existing structures to ensure bilateral coordination

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International UoM	National UoM (MS)	Reported means of achieving coordination in preparation of PFRA	Number Cross-border APSFRs reported	Reported means of achieving coordination in designation of APSFR reported
	PL8000 (PL)	Bilateral border water commissions	0	Bilateral border water commissions
Minho	ES10 (ES)	Bilateral border water commissions International working groups Bilateral coordination and working groups Informal arrangements (groups discussions and exchange of information)	2	Bilateral border water commissions International working groups Bilateral coordination and working groups Informal arrangements (groups discussions and exchange of information)
	PTRH1 (PT)	Bilateral coordination and working groups Regulations in place to enable exchange of information at international level	2	Bilateral coordination and working groups Regulations in place to enable exchange of information at international level
Duero	ES020 (ES)	Bilateral border water commissions International working groups Regulations in place to enable exchange of information at international level	0	Not applicable as no transboundary APSFRs
	PTRH3 (PT)	Bilateral coordination and working groups Regulations in place to enable exchange of information at international level	2	Bilateral coordination and working groups Regulations in place to enable exchange of information at international level
Tagus	ES030 (ES)	Bilateral border water commissions Bilateral coordination and working groups Regulations in place to enable exchange of information at international level	0	Not applicable as no transboundary APSFRs
	PTRH5 (PT)	Bilateral coordination and working groups Regulations in place to enable exchange of information at international level	0	Bilateral coordination and working groups Regulations in place to enable exchange of information at international level
Guadiana	ES040 (ES)	Bilateral border water commissions Bilateral coordination and working groups	0	Bilateral coordination and working groups
	PTRH7 (PT)	Bilateral coordination and working groups Regulations in place to enable exchange of information at international level	2	Bilateral coordination and working groups Regulations in place to enable exchange of information at international level

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8.2 Cooperation in international River Basin Commissions

The international River Basin Commissions have a key role to play in the co-ordination of flood risk assessment and management in transboundary river basins. For the Danube the ICPDR is a coordination platform for the implementation of the EU Floods Directive and for the preparation and update of the Danube Flood Risk Management Plan. A PFRA for the Danube was published in 2018, summarising the approaches and methodologies used in each Danube country, including the non-EU countries. The ICPR fulfils the same role for the Rhine and also published its PFRA in 2018. Due to differing legal and technical basis of flood protection in the different member states in the Rhine catchment there is no uniform approach to a preliminary flood risk assessment (PFRA), so the different national approaches are summarised. The PFRA for the Rhine includes details of the co-operation at national and sub-basin level between the member countries.

8.3 Examples of bilateral co-operation

For the Ems River basin, an agreement has been reached between the German Lander of Lower Saxony and North Rhine-Westphalia and the Netherlands that international co-ordination should focus on cross-border issues relating to the common goals and measures that are formulated. A document has been produced detailing how this cooperation will be achieved[2]. For the Meuse and the Sheldt river basins, Belgium and the Netherlands also produced a document explaining how coordination has been achieved[3].

Portugal and Spain participate in bilateral meetings with the Working Groups for Planning and Information Exchange of the Commission for the Application and Development of the Albufeira Convention. During such meetings, besides analysing all situations related to transboundary aspects related to floods (such as transboundary risk areas, measures with transboundary impact and exchange of data on these areas), more general methodological approaches on the subject are also discussed, including climate change in the Iberian Peninsula and strategies for data harmonisation and flood risk assessment. Italy and Slovenia are co-operating on a joint project for the Vipava/Vipacco river, VISFRIM, to develop common methodologies and technical instruments for the implementation of the PFRA, including joint risk modelling and mapping.

8.4 International cooperation developments since the previous assesssment

In the first cycle, among the most common mechanisms were the opportunities for coordination through an International River Commission, such as the International Commission for the Protection of the Danube River (ICPDR) and the International Commission for the Protection of the Rhine (ICPR). Bilateral border commissions were also relatively common, providing a formalised mechanism for two Member States to exchange information and coordinate flood risk management as well as other water management issues. Similarly, various international coordination and working groups had been established to carry out specific roles in flood risk management, including decision-making, the provision of advice, coordination of measures and the implementation of flood risk management measures.

[2] See case study 30 at the end of this document.
[3] See case study 31.

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There do not appear to have been significant changes in the mechanisms for coordination between the two cycles.

Annex A List of Member State Units of Management (River Basin Districts)

EUUOMCode	UOMName	International	InternationalName
AT1000	Danube	Y	Danube
AT2000	Rhine	Y	Rhine
AT5000	Elbe	Y	Elbe
BEEscaut_RW	Scheldt	Y	International river basin district of the Scheldt
BEEscaut_Schelde_BR	Scheldt	Y	International river basin district of the Scheldt
BEMeuse_RW	Meuse	Y	International river basin district of the Meuse
BEMaas_VL	Meuse	Y	International river basin district of the Meuse
BERhin_RW	Rhine	Y	International river basin district of the Rhine
BESchelde_VL	Scheldt	Y	International river basin district of the Scheldt
BESeine_RW	Seine	Y	No international institution formalised because of the small area concerned by the RBD in WR.
BG1000	Danube River Basin District	Y	
BG2000	Black Sea River Basin District	Y	
BG3000	East Aegean River Basin District	Y	
BG4000	West Aegean River Basin District	Y	
CY001	CYPRUS	N	CYPRUS
CZ_1000	Danube	Y	International river bazin district of Danube
CZ_5000	Elbe	Y	International river bazin district of Elbe
CZ_6000	Oder	Y	International river bazin district of Oder
DE1000	Deutsche Donau	Y	Danube
DE2000	Rhine River Basin District	Y	Rhine River Basin District
DE3000	Ems River Basin District	Y	Ems River Basin District
DE4000	Weser River Basin District	N	
DE5000	German Elbe	Y	Elbe
DE6000	Oder	Y	Odra
DE7000	Maas River Basin District (German Part)	Y	Meuse River Basin District
DE9500	Eider	Y	Eider

DE9610	Schlei/Trave	Y	Schlei/Trave
DE9650	Warnow/Peene	N	
DK1	Jutland and Funen	N	
DK2	Zealand	N	
DK3	Bornholm	N	
DK4	International (Vidå-Kruså)	Y	Vidå-Kruså
EE1	West-Estonian	N	
EE2	East-Estonian	Y	
EE3	Koiva	Y	
EL01	Western Peloponnese	N	
EL02	Northern Peloponnese	N	
EL03	Eastern Peloponnese	N	
EL04	Western Sterea Ellada	N	
EL05	Epirus	N	
EL06	Attica	N	
EL07	Eastern Sterea Ellada	N	
EL08	Thessalia	N	
EL09	Western Macedonia	Y	
EL10	Central Macedonia	Y	
EL11	Eastern Macedonia	Y	
EL12	Thrace	Y	
EL13	Crete	N	
EL14	Aegean Islands	N	
ES010	MINHO	Y	MINHO
ES014	GALICIAN COAST	N	
ES017	Eastern Cantabrian	Y	NORTE
ES018	Western Cantabrian	N	
ES020	DUERO	Y	DOURO
ES030	TAGUS	Y	International Tagus River Basin
ES040	Guadiana River Basin District	Y	Guadiana River Basin District
ES050	GUADALQUIVIR	N	
ES060	ANDALUSIA MEDITERRANEAN BASINS	N	
ES063	GUADALETE AND BARBATE	N	
ES064	TINTO, ODIEL AND PIEDRAS	N	
ES070	SEGURA	N	
ES080	JUCAR	N	
ES091	EBRO	N	
ES100	Catalan River Basin District	N	

ES110	BALEARIC ISLANDS	N	
ES120	GRAN CANARIA	N	
ES122	FUERTEVENTURA	N	
ES123	LANZAROTE	N	
ES124	TENERIFE	N	
ES125	LA PALMA	N	
ES126	LA GOMERA	N	
ES127	EL HIERRO	N	
ES150	CEUTA	N	
ES160	MELILLA	N	
FIVHA1	Vuoksi River Basin District	N	
FIVHA2	Kymijoki-Gulf of Finland River Basin District	N	
FIVHA3	Kokemäenjoki-Archipelago Sea-Bothnian Sea River Basin District	N	
FIVHA4	Oulujoki-Iijoki River Basin District	N	
FIVHA5	Kemijoki River Basin District	N	
FIVHA6	Tornionjoki IRBD	Y	Tornionjoki IRBD
FIVHA7	Teno, Näätämöjoki and Paatsjoki IRBD	Y	Teno, Näätämöjoki and Paatsjoki IRBD
FIWDA	Åland River Basin District	N	
FRA	L'Escaut, la Somme et les cours d'eau côtiers de la Manche et de la mer du Nord	Y	Scheldt
FRB1	Meuse	Y	Meuse
FRB2	La Sambre	Y	International Meuse River Basin District
FRC	Rhine	Y	Rhine
FRD	Le Rhône et les cours d'eau côtiers méditerranéens	N	
FRE	Les cours d'eau de la Corse	N	
FRF	L'Adour, la Garonne, la Dordogne, la Charente et les cours d'eau côtiers charentais et aquitains	N	
FRG	La Loire, les cours d'eau côtiers vendéens et bretons	N	
FRH	La Seine et les cours d'eau côtiers normands	N	
FRI	Les cours d'eau de la Guadeloupe	N	

FRJ	Les cours d'eau de la Martinique	N	
FRK	Les fleuves et cours d'eau côtiers de la Guyane	N	
FRL	Les cours d'eau de la Réunion	N	
FRM	Les cours d'eau de Mayotte	N	
HRC	Danube	Y	Danube
HRJ	Adriatic	Y	
HU1000	Hungarian part of the Danube River Basin District	Y	Danube River Basin District
IEGBNIIENB	Neagh Bann	Y	
IEGBNIIENW	North Western	Y	
IEROI	Republic of Ireland	N	
ITI012	Bradano	N	
ITI01319	Conca/Marecchia	N	
ITI014	Fiora	N	
ITI015	Fortore	N	
ITI017	Lemene	N	
ITI018	Magra	N	
ITI021	Reno	N	
ITI022	Saccione	N	
ITI023	Sangro	N	
ITI024	Sinni	N	
ITI025	Sele	N	
ITI026	Fissero-Tartaro-Canalbianco	N	
ITI027	Trigno	N	
ITI028	Tronto	N	
ITI029	Noce	N	
ITN001	Adige	N	
ITN002	Arno	N	
ITN003	Brenta-Bacchiglione	N	
ITN004	Isonzo	Y	Isonzo
ITN005	Liri-Garigliano	N	
ITN006	Livenza	N	
ITN007	Piave	N	
ITN008	Po	Y	Po
ITN009	Tagliamento	N	
ITN010	Tevere	N	
ITN011	Volturno	N	
ITR051	regionale Veneto	N	
ITR061	regionale Friuli Venezia Giulia	N	

ITR071	regionale Liguria	N	
ITR081	regionale Emilia Romagna	N	
ITR091	regionale Toscana Costa	N	
ITR092	regionale Toscana Nord	N	
ITR093	regionale Toscana Ombrone	N	
ITR111	regionale Marche	N	
ITR121	regionale Lazio	N	
ITR131	regionale Abruzzo	N	
ITR141	regionale Molise	N	
ITR151	regionale Campania Nord Occidentale	N	
ITR152	regionale Destra Sele	N	
ITR153	regionale Sinistra Sele	N	
ITR154	regionale Sarno	N	
ITR161I020	regionale Puglia/Ofanto	N	
ITR171	regionale Basilicata	N	
ITR181I016	regionale Calabria/Lao	N	
ITR191	regionale Sicilia	N	
ITR201	regionale Sardegna	N	
ITSNP01	Serchio	N	
LT1100	Nemunas	Y	
LT2300	Venta	Y	Venta
LT3400	Lielupe	Y	Lielupe
LT4500	Dauguva	Y	Dauguva
LU RB_000	Mosel	Y	Rhine
LU RB_001	Chiers	Y	Maas
LVDUBA	Daugava river basin district	Y	Daugava river basin district
LVGUBA	Gauja river basin district	Y	Gauja river basin district
LVLUBA	Lielupe river basin district	Y	Lielupe river basin district
LVVUBA	Venta river basin district	Y	Venta river basin district
MTMALTA	Malta	N	
NLEM	Ems	Y	
NLMS	Meuse	Y	
NLRN	Rhine	Y	
NLSC	Scheldt	Y	
PL1000	Danube River Basin District	Y	Danube River Basin District
PL2000	Vistula River Basin District	Y	Vistula River Basin District

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PL3000	Swieza River Basin District	Y	Swieza River Basin District
PL4000	Jarft River Basin District	Y	Jarft River Basin District
PL5000	Elbe River Basin District	Y	Elbe River Basin District
PL6000	Oder River Basin District	Y	Oder River Basin District
PL6700	Ucker River Basin District	Y	Ucker River Basin District
PL7000	Pregolya River Basin District	Y	Pregolya River Basin District
PL8000	Nemunas River Basin District	Y	Nemunas River Basin District
PL9000	Dniester River Basin District	Y	Dniester River Basin District
PTRH1	Minho and Lima		
PTRH2	Cavado, Ave and Leca		
PTRH3	Douro		
PTRH4A	Vouga, Mondego and Lis		
PTRH5A	Tagus and West Rivers		
PTRH6	Sado and Mira		
PTRH7	Guadiana		
PTRH8	Algarve Rivers		
PTRH9	Azores		
PTRH10	Madeira		
RO1	BANAT HIDROGRAPHICAL AREA	Y	Danube River District
RO10	SIRET HYDROGRAPHICAL AREA	Y	Danube River District
RO1000	Danube	Y	Danube River District
RO11	PRUT-BARLAD HYDROGRAPHICAL AREA	Y	Danube River District
RO2	JIU RIVER BASIN	Y	Danube River District
RO3	OLT RIVER BASIN	Y	Danube River District
RO4	ARGES-VEDEA HYDROGRAPHICAL AREA	Y	Danube River District
RO5	IALOMITA-BUZAU HYDROGRAPHICAL AREA	Y	Danube River District
RO6	Danube Basin	Y	Danube River District
RO7	MURES RIVER BASIN	Y	Danube River District

RO8	CRISURI HYDROGRAPHICAL AREA	Y	Danube River District
RO9	SOMES-TISA HYDROGRAPHICAL AREA	Y	Danube River District
SE1	1. Bothnian Bay (Sweden)	N	
SE1TO	1. Bothnian Bay (International district Torne river - Sweden)	Y	1. Bottenviken (Int. dist. Torneälven - Sverige)
SE2	2. Bothnian Sea (Sweden)	N	
SE3	3. North Baltic Sea (Sweden)	N	
SE4	South Baltic Sea (Sweden)	N	
SE5	5. Skagerrak and Kattegat (Sweden)	N	
SI_RBD_1	Danube River Basin District	Y	Danube River Basin District
SI_RBD_2	Adriatic River Basin District	Y	Adriatic River Basin District
SK30000FD	Vistula	Y	Vistula
SK40000FD	Danube	Y	Danube

Annex B Definitions of Source, Mechanisms and Characteristics of floods[4]

Sources

Fluvial	Flooding of land by waters originating from part of a natural drainage system, including natural or modified drainage channels. This source could include flooding from rivers, streams, drainage channels, mountain torrents and ephemeral watercourses, lakes and floods arising from snow melt.
Pluvial	Flooding of land directly from rainfall water falling on, or flowing over, the land. This source could include urban storm water, rural overland flow or excess water, or overland floods arising from snowmelt.
Groundwater	Flooding of land by waters from underground rising to above the land surface. This source could include rising groundwater and underground flow from elevated surface waters.
Sea Water	Flooding of land by water from the sea, estuaries or coastal lakes. This source could include flooding from the sea (e.g., extreme tidal level and / or storm surges) or arising from wave action or coastal tsunamis.
Artificial Water-Bearing Infrastructure	Flooding of land by water arising from artificial, water-bearing infrastructure or failure of such infrastructure. This source could include flooding arising from sewerage systems (including storm water, combined and foul sewers), water supply and wastewater treatment systems, artificial navigation canals and impoundments (e.g., dams and reservoirs).
Other	Flooding of land by water due to other sources, can include other tsunamis.

Mechanisms

Natural Exceedance	Flooding of land by waters exceeding the capacity of their carrying channel or the level of adjacent lands.
Defence Exceedance	Flooding of land due to floodwaters overtopping flood defences.
Defence or Infrastructural Failure	Flooding of land due to the failure of natural or artificial defences or infrastructure. This mechanism of flooding could include the breaching or collapse of a flood defence or retention structure, or the failure in operation of pumping equipment or gates.
Blockage / Restriction	Flooding of land due to a natural or artificial blockage or restriction of a conveyance channel or system. This mechanism of flooding could include the blockage of sewerage systems or due to restrictive channel structures such as bridges or culverts or arising from ice jams or landslides.

[4] Reporting guidance, https://cdr.eionet.europa.eu/help/Floods/Floods_2018/index.html

Other	Flooding of land by water due to other mechanisms, for instance wind setup floods.

Characteristics

Flash Flood	A flood that rises and falls quite rapidly with little or no advance warning, usually the result of intense rainfall over a relatively small area.
Snow Melt Flood	Flooding due to rapid snow melt, possibly in combination with rainfall or blockage due to ice jams.
Other rapid onset	A flood which develops quickly, other than a flash flood.
Medium onset flood	An onset of flooding that occurs at a slower rate than a flash flood.
Slow onset flood	A flood which takes a longer time to develop.
Debris Flow	A flood conveying a high degree of debris.
High Velocity Flow	A flood where the floodwaters are flowing at a high velocity.
Deep Flood	A flood where the floodwaters are of significant depth.
Other	Other characteristics, or no special characteristics.

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Annex C Case Studies from Member States

Case Study 1: Slovakia PFRA

Slovakia included detailed descriptions of past floods in both the national PFRA report, and the PFRA reports produced for each sub-basin. These included historic floods, as well as floods that have occurred during the second cycle (2012-2018). The information provided included a detailed description of the precipitation levels in each year, the conditions that led to flooding, and an overview of the consequences of each flood. The UoM reports also include information on the expenditure incurred for the purposes of flood security work, flood rescue work and flood damage (see machine translated table below for the Dunajec and Poprad sub-basin of the Vistula UoM. Note for the purposes of this case study only data for 2012-2018 has been shown)

Table 4.1. Overview of expenditures on flood protection work, flood rescue work and flood protection work damages in Slovakia in the period 1997 - 2017

Year	Floods Security work	Floods rescue work	Flood damage	Expenses and damages together
2012	460 624	369 427	2 435 268	3 265 319
2013	4 750 477	2 729 905	13 460 597	20 940 979
2014	11,912,949	5,657,451	36 959 006	54 529 406
2015	602 778	1 141 063	3 124 078	4 867 919
2016	1 270 825	843 174	12 670 107	14 784 107
2017	2 273 258	875 363	7 873 071	11 021 693

Case Study 2: Poland – Maps of retention areas

Poland produced maps of retention areas which were provided at national level, RBD level (for the Vistula and the Oder only) and at sub-basin level. The picture below is an example of this map at national level.

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Case Study 3: Interactive portals

Twelve Member States provided links to specific flood related geoportals that allowed information directly related to the PFRA to be examined interactively.

BE (Flanders): https://www.waterinfo.be/kaartencatalogus

DE: https://geoportal.bafg.de/karten/HWRM_Aktuell/?tabs=on

DK: https://miljoegis.mim.dk/spatialmap?&profile=oversvoem2

EE: https://xgis.maaamet.ee/xgis2/page/app/yua

ES: https://sig.mapama.gob.es/snczi/index.html?herramienta=DPHZI

FI: https://www.ymparisto.fi/tulvakartat

IE: https://www.floodinfo.ie/map/floodmaps/

LT: https://potvyniai.aplinka.lt/map

LU:
https://map.geoportail.lu/theme/eau?lang=de&zoom=10&X=683194&Y=6423615&version=3&layers=&opacities=&bgLayer=topo_bw_jpeg&rotation=0

NL: www.risicokaart.nl

SE: https://gisapp.msb.se/Apps/oversvamningsportal/index.html

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SI:
https://gisportal.gov.si/portal/apps/webappviewer/index.html?id=11785b60acdf4f599157f33aac8556a6

Case Study 4 – Belgium (Wallonia)

In 2017 Wallonia created an inventory of past floods (BRelI - Base de données des RELevés d'Inondations). Significant past floods are identified based on the information held within this inventory. The sources of information include:

- Flood markers;
- Photo database;
- Press sources (SPW press, Walloon Brabant press, press clippings);
- Flood report;
- Public calamities (supplemented by data from the Centre Régional de Crise(CRC));
- Insurance data (Assuralia);
- MRI data;
- Municipal surveys; and
- The Technical Committees by Sub-Hydrographic Basin (Comités Techniques par Sous-Bassin Hydrographique (CTSBH)).

Case Study 5 –The Republic of Ireland

The Republic of Ireland has introduced a data collection form[5] to allow for the collection and collation of more detailed information on the occurrence and impact of flooding in the second cycle. The form seeks information on a range of impacts, including numbers of residential and commercial properties that were flooded, the infrastructure and heritage affected and information on any environmental impacts.

[5] https://www.floodinfo.ie/static/floodmaps/docs/past_floods/Past_Flood_Event_Technical_Form_V3.2.pdf

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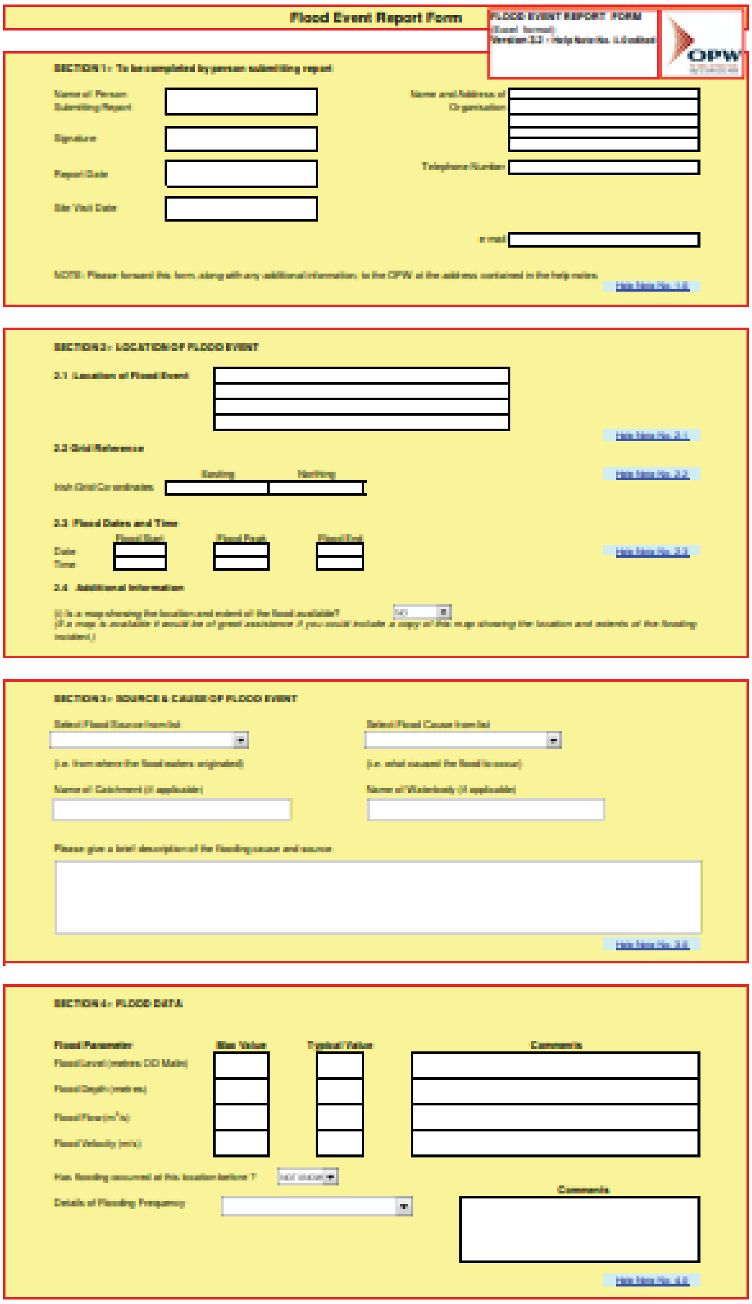
Flood Event Report Form

FLOOD EVENT REPORT FORM

SECTION 1: To be completed by person submitting report

Name of Person Submitting Report

Signature

Report Date

Site Visit Date

Name and Address of Organisation

Telephone Number

e-mail

SECTION 2: LOCATION OF FLOOD EVENT

2.1 Location of Flood Event

2.2 Grid Reference

Easting Northing

Irish Grid Co-ordinates

2.3 Flood Dates and Time

Flood Start Flood Peak Flood End

Date

Time

2.4 Additional Information

SECTION 3: SOURCE & CAUSE OF FLOOD EVENT

Select Flood Source from list

(i.e. from where the flood waters originated)

Select Flood Cause from list

(i.e. what caused the flood to occur)

Name of Catchment (if applicable)

Name of Waterbody (if applicable)

Please give a brief description of the flooding cause and source

SECTION 4: FLOOD DATA

Flood Parameter	Max Value	Typical Value	Comments
Flood Level (metres OD Malin)			
Flood Depth (metres)			
Flood Flow (m^3/s)			
Flood Velocity (m/s)			

Has flooding occurred at this location before ?

Details of Flooding Frequency

Comments

Case Study 6 – Portugal Collection of Information on Historic Floods

To gather information on historic floods for the second cycle, Portugal collected the following information:

- An online form filled in by local and national authorities with competence in flood event management,
- Other sources of information and databases from the National Civil Protection Authority, the National Water Resources Information System, the Portuguese Insurance Association and COPERNICUS satellite images,
- Newspaper articles (especially on damage caused by flood events),
- Characterization studies in the scope of the Coastal Zone Planning/Programs,

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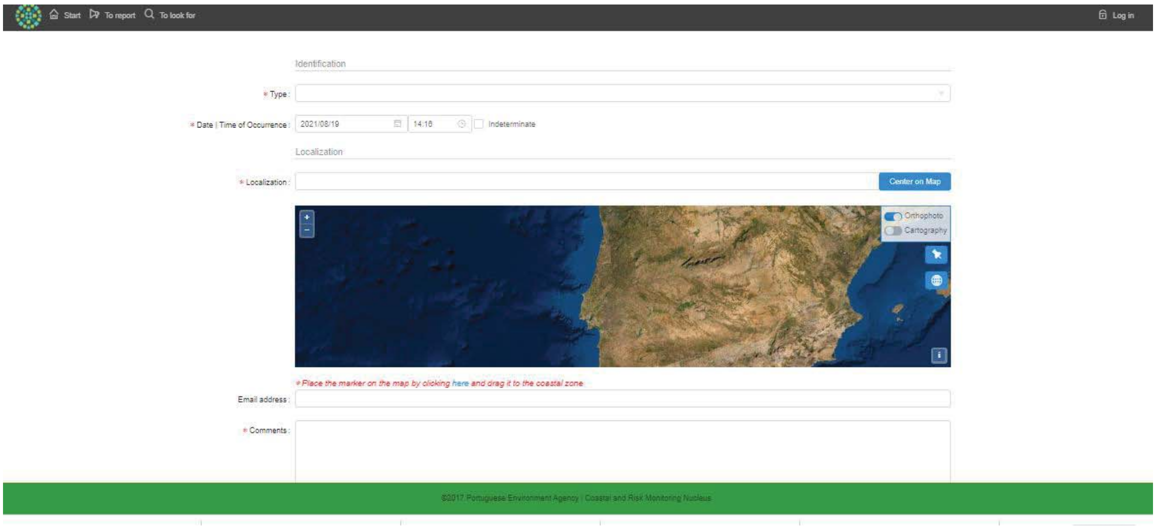
- Specific technical studies and projects carried out in the context of coastal protection/defence interventions,

- Existing publications in academic and scientific articles, and

- Information produced in the context of previous local/regional monitoring projects/studies.

In addition, specifically in relation to coastal flooding, the recording of occurrences in the field has recently been optimized through the creation of an online platform (via PC or smartphone), which allows registration and communication in real time of the occurrence of flooding by the general public (see screen shot below).



Case Study 7: Romania

The shows an extract of the data reported to the EIONET CDR on the duration, area or length, and frequency of past floods for the UoM RO6.

UoM	Area	Date of Commencement	Duration of Flood	Length	Frequency	Name Of Flood Event	Flood Event Code
RO6		2016-06-01	1	2.43	40%	Inundatie 2016 iunie r. Luncaviţa - loc. Luncaviţa	RO6-14.01.050....-01-2016.06-L
RO6		2016-09-19	1	2.71	20%	Inundatie 2016 septembrie r. Taiţa - loc. Horia	RO6-15.01.003....-01-2016.09-L
RO6	1.00	2010-06-22	1		10%	Inundatie 2010 iunie - loc. Cernavodă, jud. Constanţa	RO6-60785-01-2010.06-L
RO6	10.38	2011-07-10	1		20%	Inundatie 2016 octombrie - loc. Constanţa, jud. Constanţa	RO6-60428-01-2016.10-L
RO6	2.22	2015-10-12	1		10%	Inundatie 2015 octombrie - loc. Corbu, jud. Constanţa	RO6-61522-01-2015.10-L
RO6	5.78	2010-06-25	1		10%	Inundatie 2010 iunie - loc. Tulcea, jud. Tulcea	RO6-159623-01-2010.06-L
RO6	5.78	2015-02	2		20%	Inundatie 2015 februarie - loc. Tulcea, jud. Tulcea	RO6-159623-01-2015.02-L

Case Study 8 - Hungary

In the last week of May 2013 and the first days of June, a cyclone developed in central Europe between the Atlantic Ocean and North-Eastern Europe. As a result of the process, a significant amount of precipitation fell in the upper catchment areas of the Danube, resulting in a significant flood wave. The floods of the Danube and the Inn met at Passau on 3 June, the water level peaked at 1 238 cm; the water level was about 2 m higher than the 2002 peak. Major Austrian tributaries (Traun, Enns, Ybbs) had peaks in several places exceeding previous peaks. In the Hungarian Upper Danube section, water levels

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approaching the highest water level ever recorded were expected to be reached in some places. The flood entered the country on June 7 and left the country seven days later, on June 14. With the exception of Mohács, the water level exceeded the previous highest observed water level (LLNV) at all major water monitoring stations. The exceedance of the LLNV was the highest in the case of Komárom station, here it exceeded the largest water level of 802 cm measured in 2002 by 43 cm. At Budapest, a peak water level of 891 cm, 31 cm above the LLNV, was registered. The water flow in Dévény, which characterizes the amount of water entering Hungary, exceeded 10,500 m^3/s. A total of 73 780 people took part in manning the defences against the flood, which involved raising and supporting the fortifications and building new fortifications. In addition, it became necessary to individually protect high-value facilities. The length of protection built exceeded 9.5 km, using more than 5 million sandbags. Due to the flood wave on the Danube between 7 June and 14 June 2013, 1 570 people had to be evacuated on 10 June. There was no personal injury or material damage resulting from the flood.

Case Study 9 – Czechia – Criteria for the identification of significant past floods

Czechia has developed a clear methodology for the assessment of past floods which incorporates several criteria for defining significant adverse impacts of past floods on humans, housing, society, the environment, cultural heritage and economic effects against a scale chosen to determine the degree of adverse effects of floods:

N - insignificant or unknown, 1 -– low, 2 -– high and 3 – extreme.

The criteria for individual types of various flooding situations are listed below:

1. River (fluvial) flood:
    - achieved at least a 100-year probability of recurrence (Q100)
    - observed in at least three specific profiles on watercourses
    - affected areas larger than 2 000 km^2
2. Flood from torrential rains:
    - claimed at least three human victims lives or the damage exceeded CZK 50 million
3. An accident on a waterworks or water management infrastructure:
    - if it did not occur as a result of natural floods, it claimed at least three human lives
    - if it occurred as a result of a natural flood, recurrence was increased downstream to at least 500 years and at least three human lives were lost.
4. Other types of floods (pluvial from groundwater):
    - damages exceeded CZK 250 million

Case Study 10 – The Netherlands

The PFRA report for the Netherlands includes an assessment of the impact of past floods on human health, measured by the number of fatalities and the number of evacuations

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carried out (both humans and livestock) and also an assessment of the economic impact in terms of the number of properties damaged, the value of livestock affected and the total damage (in millions of Guilders).

Tabel 3.1 Overzicht van historische overstromingen met significante negatieve effecten en een inschatting van het risico op herhaling

Hoofdwatersysteem

	Overstroming					Gevolgen		
nr.	Datum	Bron	Omvang van overstroming	Aard / route van overstroming	Indicatie van frequentie	Gezondheid van de mens	Economische bedrijvigheid[1]	Risico van herhaling
1	1916 januari	Noordzee, Waddenzee (stormvloed-A14)	Gebieden rond de toenmalige Zuiderzee	Groot aantal doorbraken (A22,A23,A38)	Zeer zeldzaam	19 slachtoffers	Schade aan dijken, grote schade aan houten huizen in Marken, scheeps-rampen	Nihil
2	1926 januari	Rijn en Maas (A11)	Grote delen van het rivierengebied	Groot aantal doorbraken (A22,A23,A38)	1: 100 jaar Hoogste gemeten afvoer van Rijn: 12.600 m^3/sec.	Geen slachtoffers	3.000 huizen zwaar beschadigd, 10 miljoen gulden schade	Nihil
3	1953 februari	Noordzee (stormvloed-A14)	1650 km^2 in Zuidwest-Nederland	Zeer groot aantal doorbraken (A22,A23,A38)	1:100 jaar	1.835 slachtoffers, 72.000 evacuaties	3.000 huizen en 300 boerderijen verwoest, 47.000 stuks vee verdronken,1,5 mil-jard gulden schade	Nihil
4	1993	Maas (A11)	180 km^2	Buiten oevers treden van rivier (A21,A35)	1:100 tot 1:200 jaar	Geen slachtoffers, 8.000 evacuaties	Ca. 250 miljoen gulden, nieuwbouw-wijken onder water	Nihil door uitvoering Maaswerken
5	1995 januari	Maas (A11)	180 km^2	Buiten oevers treden van rivier (A21,A35)	1:100 jaar	Geen slachtoffers, wel evacuaties	Directe schade geraamd op 150 miljoen gulden	Nihil door uitvoering Maaswerken
6	1995	Rijn en zijn	250 km^2	Overstroming van	ca. 1:100	Geen slachtoffers,	Nihil	Kleine kans op

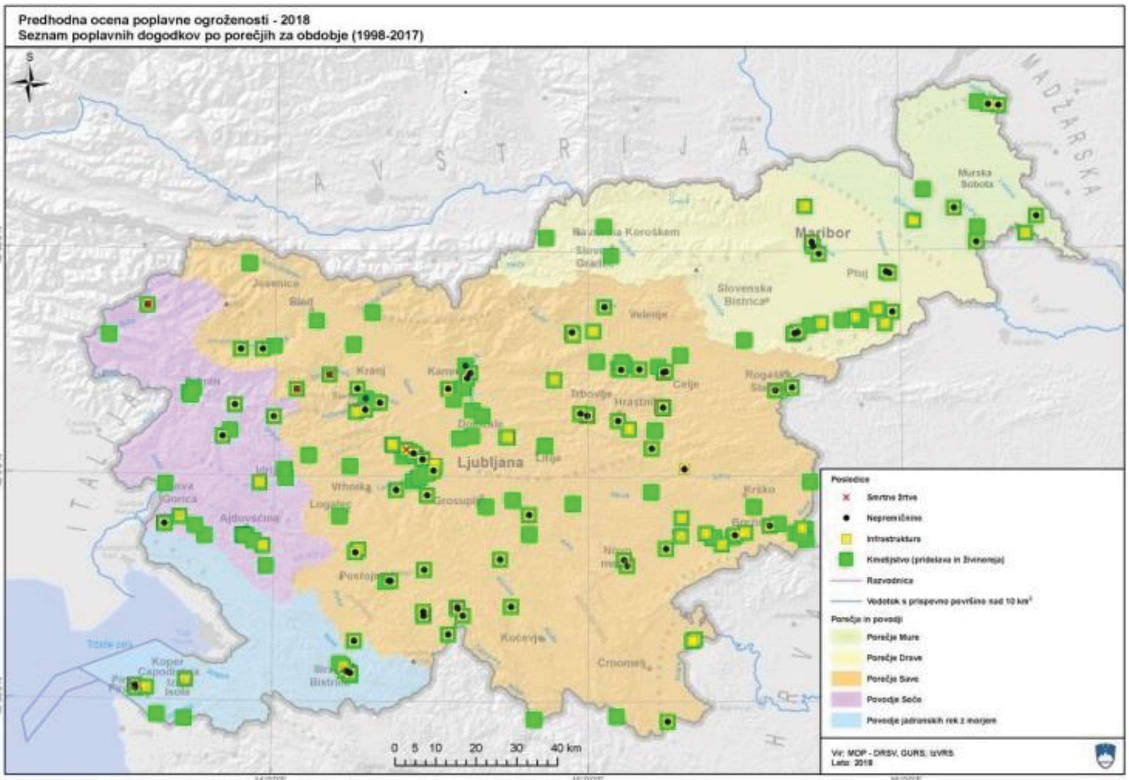
Case Study 11 – Latvia

For each significant past flood, Latvia has included a textual summary of the resulting damage and the level of financial assistance provided to repair the damage. An example (translated into English) is given below:

"The territory of Daugavpils city is exposed to the risk of floods, which is associated with both spring floods due to melting snow and rain, and ice congestion. Given that the city's residential districts are located on both banks of the Daugava River, and are partly in the river floodplain, it can be stated that in the last 10 years flooding has been observed every spring. However, in 2010 and 2013, the water level of the Daugava exceeded the "dangerous" mark of 93.43 m LAS (93.30 m BS), at which both the streets of Grīva district and several houses on the left bank of the river – from embankments to Nometņu Street were inundated. The floods of 2010 caused a loss of 124 969 lats (almost €180 000) to Daugavpils County Council of which €124 469 euro was allocated to road repairs. The spring floods of 2013 flooded about 700 houses and Daugavpils municipality received from the state budget only 4058 lats (€5774) for the payment of compensation for losses caused by floods. Daugavpils City Council was granted funding of €277 592 to prevent losses during the spring 2013 floods. At the end of 2013, a protective dam was built in Daugavpils, which protects the Grīva cemetery from flooding. In 2010, Ilūkste County Council received €176 895 for road repairs due to flood damage. In 2013, to Ilūkste municipality €116 403 was allocated for road repairs to cover expenses related to the spring flood."

Case Study 12 – Slovenia

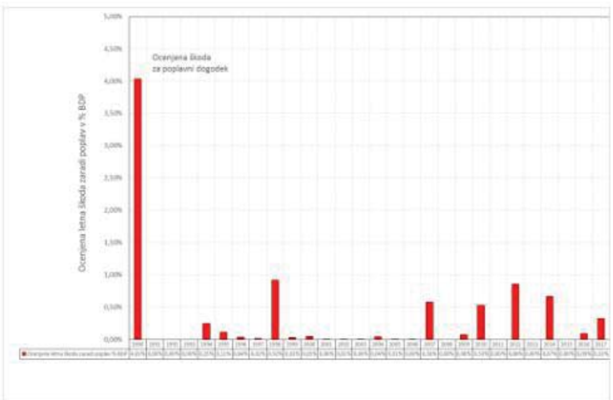
An example of one of the maps presenting areas of flood damage from the PFRA document.



Slika 15. Prikaz območij dogodkov glede na posledice za obdobje 1998-2017

Slovenia presentation of the yearly damage caused by floods in % of the GDP for the whole country for the years 1990 – 2017 in the PFRA document.

Predhodna ocena poplavne ogroženosti RS, junij 2019



Slika 16. Ocenjena letna škoda zaradi poplav 1990-2017

Leto	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Bruto domači proizvod (mio EUR)	13.674	10.271	9.688	10.849	12.162	15.704	16.345	17.456	18.761	20.240	21.288	22.505	24.108	25.344
Ocenjena letna škoda zaradi poplav (mio EUR)	551,7				30,3	18	6,16	3,48	173	6,1	10,2	0,43	2,26	0,37
Ocenjena letna škoda zaradi poplav % BDP	4,03%	0,00%	0,00%	0,00%	0,25%	0,11%	0,04%	0,02%	0,92%	0,03%	0,05%	0,00%	0,01%	0,00%

Leto	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Bruto domači proizvod (mio EUR)	26.764	28.244	30.453	34.562	37.280	35.311	35.416	36.896	36.076	36.239	37.615	38.837	40.418	43.278
Ocenjena letna škoda zaradi poplav (mio EUR)	11,4	2,22	0,21	200		27,4	188		310,9		251,2		36,8	143,1
Ocenjena letna škoda zaradi poplav % BDP	0,04%	0,01%	0,00%	0,58%	0,00%	0,08%	0,53%	0,00%	0,86%	0,00%	0,67%	0,00%	0,09%	0,33%

Case Study 13 – Portugal

Once information had been gathered on the impact of flood events, the UoMs on mainland Portugal classified each past flood events based on the severity of their impacts. This was done according to the use of selected indicators for the evaluation of significant impacts. The impact on the population was ranked qualitatively on a scale of 1 – 5 where 1 is low and 5 is very high. The number of people affected were ranked on a quantitative scale of 1 – 4 where 1 is <10 and 5 is >100. The impact on economic activities was ranked on a scale of 1-4 where 1 is low and 4 is very high, and the losses were ranked on a quantitative scale of 1 -6 from 1 being <$30,000 to 6 being > €1,000,000. The economic activities considered were listed as being private propriety, infrastructure, agricultural fields and industries and other economic activities. No information has been presented on the basis for the selection of these indicators.

The criteria for the selection of significant events were then combined with an equal weighting applied to those receptors on which the impact of flooding was considered to be most serious. Specifically, the following formula was applied:

$$(A>=4) \vee (B>=4) \vee (C>=3) \vee (D>=5)$$

where:

A = Impact on the population, B = Number of affected people, C = Impact on economic activities and D = Losses.

and

- Impact on the population - high (value 4, according to the classification presented);
- Number of people affected - 50 to 100 (value 4, according to the classification presented);
- Impact on economic activities - high (value 3, according to the classification presented);
- Losses - 500 000 to 1 000 000 Euros (value 5, according to the classification presented).

Those events that met the criteria in the formula above were then considered for designation as an APSFR. Events where there was not sufficient information to allow this assessment to take place, but where it could be demonstrated that there had been impacts on the environment or cultural heritage were also considered for designation as an APSFR.

Case Study 14 – Denmark

Assessment of the extent of flooding (English (machine) translation below)

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OVERSVØMMELSE			'Udstrækning'
0	Ingen kilder, der oplyser om oversvømmelse eller sandsynliggør, at der har været oversvømmelse	Ingen eller ringe datarådighed	Ingen datarådighed, ingen eller ringe oversvømmelse, eller begrænset til havnearealer mv.
1	Oplysning om oversvømmelse, men ikke redegjort for omfanget på oversvømmede lokaliteter	Ingen samtidig kilde med angivelse af lokalitet og omfang. Fragmentarisk kildedækning.	Betydelig oversvømmelse er forekommet på en eller enkelte lokaliteter
2	Oplysning om lokaliteter, og kilder sandsynliggør, at omfang berører mennesker direkte	Oversvømmelsens udstrækning synes geografisk dækket, men med mangelfuld oplysning om omfang	Betydelig oversvømmelse er forekommet langs en længere kyststrækning
3	Uddybende beskrivelser fra flere lokaliteter af uafhængige kilder.	Oversvømmelsens omfang og udstrækning er dokumenteret for betydende lokaliteter	Betydelig oversvømmelse er forekommet vidt udbredt indenfor et eller flere farvandsområder

Scale	Data availability	Data quality	Phenomena
0	No flood reports or probabilities of flooding	No or little data availability	No data availability, no or little flooding, or limited to port areas, etc.
1	Information on flooding, but the extent of flooded sites is not explained	No simultaneous source indicating location and extent. Fragmentary source coverage.	Significant flooding has occurred at one or some localities
2	Information about localities and sources makes it probable that extent affects people directly	The extent of the flooding seems geographically covered, but with insufficient information on the extent	Significant flooding has occurred along a longer stretch of coastline
3	Detailed descriptions from several sites of independent sources	The extent and extent of the floods have been documented for significant localities	Significant flooding has occurred widely within one or more waters

Case Study 15 – Luxembourg

A combination of previously high levels of snowfall, and moderate rainfall, caused a rapid snow melt resulted in flooding in Luxemburg in January 2011. The Canadian satellite RADARSAT was scheduled for the evening of January 7, 2011, to cover the Alzette and Sûre valleys during the flight over on January 8, 2011 at around 6 p.m. (time winter). Thanks to the radar image obtained (example below), a detailed mapping of the flood fields could be carried out in just a few hours. The cartographic products produced will make it possible in the near future to produce hydraulic model calibration and validation operations in the sectors studied and at risk. In addition to the satellite images, many photos were taken on the ground, as well as by helicopter overflights, which also constitute so many additional sources of information for these modelling operations.

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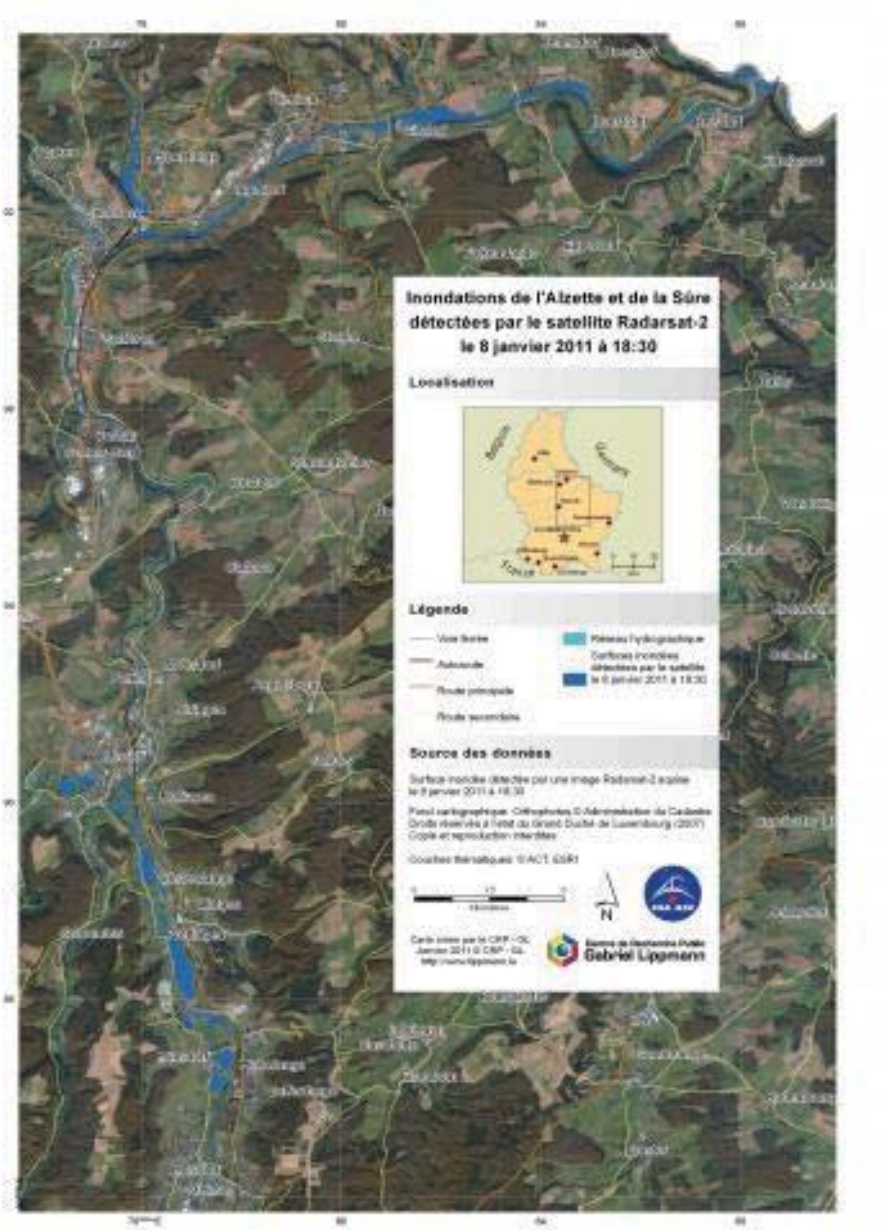

Figure 4.1. Champs d'inondation dans les plaines alluviales de l'Alzette et de la Sûre le 8 janvier 2011 à 18hrs30

Case Study 16 – Denmark: Vulnerability matrix

Denmark used a national approach, developed under an EU-project[6] for assessing potential adverse consequences of future floods. The same approach is used for stormfloods and fluvial flooding and is based on assessing and mapping the vulnerability of areas to flooding. It considers direct and indirect as well as tangible and intangible damages of flooding.

Denmark used the enumeration of potential adverse consequences of future floods provided in Article 4.2(d) of the FD as a point of departure to define criteria, which describe the adverse consequences of floods. The criteria are called "vulnerability indicators". To assure coherence of the approach used across all UoMs, the data sets which were used to describe the vulnerability indicators, had to be nationally available. The

[6] http://www.risckit.eu/

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approach considers several vulnerability aspects (population density, type of land-use, cultural heritage, (transport) infrastructure, potentially polluting activities, emergency services, critical infrastructure, economic activity), which are understood to cover the aspects mentioned in Article 4.2 (d) of the FD. For each aspect its vulnerability is assessed/indexed separately on a scale from 1 to 5 (low to high) and later merged into one overall vulnerability index. In the indexing process mainly qualitative data (i.e. type of infrastructure) was used, except for population density and economic activity (described by number of employees), where absolute numbers were used for indexing. So potential future adverse consequences are not really quantified. In the process of indexing vulnerability indicators expert judgement from the CA (the Danish Coastal Authority) was used in cooperation with other relevant authorities.

Case Study 17 – Finland: Methodology for defining future floods[7]

In the seven mainland UoMs in Finland, the assessment of future flood risks is made using an altitude model and spatial data, which considers the location and hydrological and geomorphological characteristics of water bodies, the effectiveness of regulatory and flood defense structures and other available flood risk management measures, and long-term change of conditions, including climate change impacts. Data on the coverage and damage potential of future floods were obtained from flood risk maps. In the spatial data analysis, low, potentially flood-prone areas were identified based on topography and the location of water bodies and their hydrological properties. Flood hazard maps and the flood area of the preliminary flood risk assessment modeled as described above were combined with spatial data describing land use. Based on the number of inhabitants and floor area of the building and apartment register, the so-called flood risk boxes and flood risk areas were calculated. The spatial data produced, and the calculated damage potential indicators provided a tool for identifying flood risk areas or areas insignificant to flood risks. The following factors have been taken into account in assessing the harmful consequences of future floods: number of inhabitants, number of buildings that are difficult to evacuate, economic activities securing vital functions (e.g. ports and airports), infrastructure (e.g. lost connections), community activities (e.g. water, energy, and telecommunications outages), polluting installations/activities, adverse effect on the environment (e.g. deterioration of a water body and pollution of a protected area due to discharges), cultural heritage (e.g. damage to cultural environments or protected buildings, damage to archival and museum objects, etc.), frequency of flooding, the origin and nature of the flood, land use changes (e.g. zoning pressure) as well as regional and local conditions.

Case Study 18 – Slovenia: Assessment of future flood risk

Slovenia has significantly revised its methodology for the assessment of future flood risk for the second cycle PFRA, and has published details of this in a specific report[8]. Potential future floods are presented by means of a flood hazard potential map, which is compiled from the following flood records:

[7] Main PFRA document: http://wwwi9.ymparisto.fi/i9/fi/trhs/tulvariskien_alustava_arviointi_suomessa_vuonna_2018.pdf

[8] Methodology for the Amendment of the Preliminary Flood Risk Assessment (Determination of New or Additional Areas of Significant Flood Risk) https://www.gov.si/assets/ministrstva/MOP/Dokumenti/Voda/NZPO/e6c54974b8/PFRA_metodologija_IzVRS.pdf

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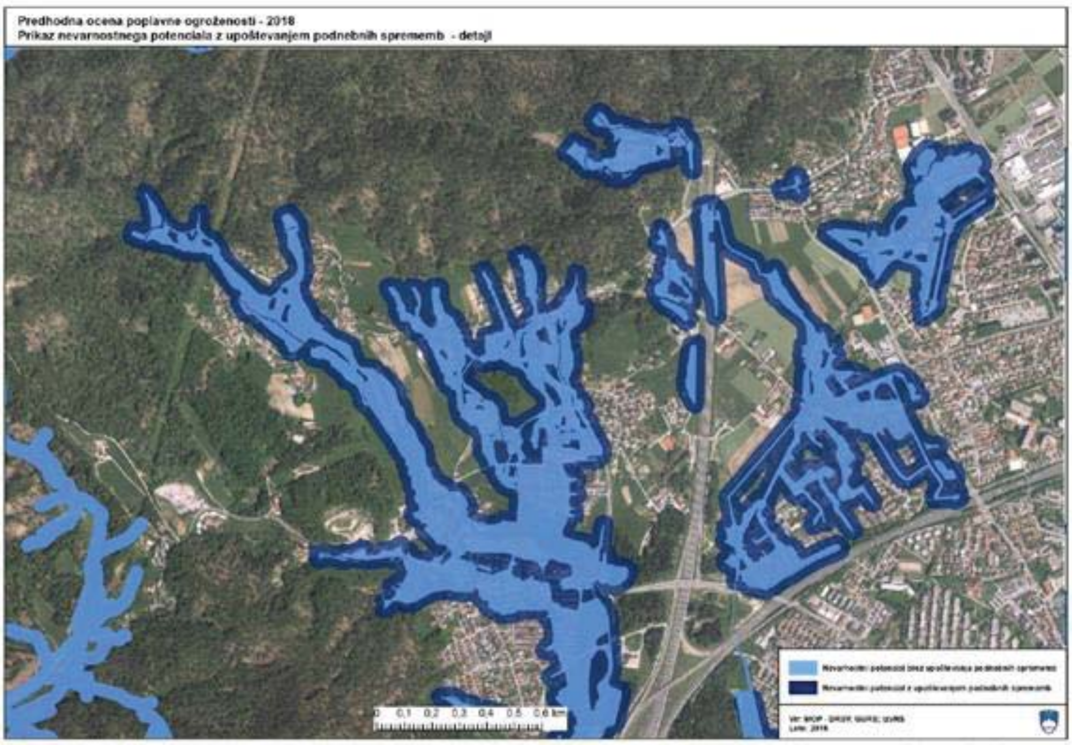
- Integral flood risk maps, a collection of results of studies investigating the flood risk in areas where urban development is anticipated. These studies use a common, nationally defined, methodology but do not cover all areas.

- A flood warning map which covers the whole country and shows the extent of flood areas according to the frequency of occurrence (frequent, rare and very rare).

- A database of past flood events that mainly contains data on the location where past flood events occurred.

- Maps of potential torrential flooding (all watercourses with an average inclination of the catchment area greater than 25% are included; the area in question is the water network of these watercourses with a 25 m offset on each side of the watercourse axis).

The final flood hazard potential map also takes the expected changes in water flow resulting from climate change into consideration. An example of the final map from the PFRA[9] is shown below. Other information, including flood risk maps, flood warning maps and the database of past flood events are available on the Slovenian map viewer[10].



Slika 43. Karta nevarnostnega potenciala (z upoštevanjem vpliva podnebnih sprememb) - detajl

Case Study 19 – Lithuania: Assessment of potential consequences of future flood risk

In Lithuania locations which are subject to future flood risk are identified by considering the location of significant past floods, topography, expected climate change impacts, location of water courses and their general hydrological and geomorphological characteristics. Once rivers or territories with future flood risks are identified, an

9 https://www.gov.si/assets/ministrstva/MOP/Dokumenti/Voda/NZPO/e56d7a6180/predhodna_ocena_poplavne_ogrozenosti_2019.pdf

10 https://gisportal.gov.si/portal/apps/webappviewer/index.html?id=11785b60acdf4f599157f33aac8556a6

assessment of adverse consequences of future floods is performed. The assessment mainly relies on the land use analysis and results in estimates of potentially flooded agricultural and urban areas, infrastructure, affected inhabitants and protected areas.

The potential monetary damage of future floods is estimated with regard to economic activities (taking into account potential damage to property, infrastructure, losses of agricultural production). Damage estimates for different probability floods (0.1%, 1%, 10%,) are provided in the interactive flood hazard and risk map[11] for each grid cell. Based on the information provided on the webpage of the Lithuanian EPA[12], the consequences of future floods with respect to human health, environment, cultural heritage and economic activity are then assessed with the purpose of developing flood risk maps. The assessment is carried out by applying spatial analysis tools and combining the data on populated areas, inhabitant numbers, location of protected areas and cultural heritage and areas of economic activities with the information from flood hazard maps.

The consequences to human health are assessed in terms of numbers of potentially affected inhabitants whilst the assessment of damage to economic activity covers the assessment of:

- potential adverse consequences for property,
- potential adverse consequences for infrastructure (roads, buildings),
- potential adverse consequences for land use in rural areas (lost forest and agricultural production),
- potential negative consequences for economic activity (production, construction, services),
- other potential negative consequences (indirect economic and social costs, emergency costs).

Potential consequences for environment and cultural heritage are assessed in terms of numbers of the following present in the flood hazard areas:

- installations covered by Annex I of the IPPC Directive (96/61/EB) which in the case of flooding can cause accidental pollution,
- wastewater treatment plants,
- landfills and other waste management infrastructure,
- water abstraction sites and their protection zones,
- bathing sites,
- Natura 2000 sites, important for protection of birds and habitats,
- cultural heritage.

The potential social consequences are estimated based on statistical data on inhabitants' age, health status, income, unemployment rate, living conditions. Assessment results, expressed as a coefficient ranging from 0 (low risk) to 1 (high risk), are presented in the interactive flood hazard and risk map[13].

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[11] https://potvyniai.aplinka.lt/map
[12] http://vanduo.gamta.lt/cms/index?rubricId=6d87deab-3ecc-412a-9b66-7fd6361f26ba
[13] https://potvyniai.aplinka.lt/map

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Case Study 20 – Latvia: Detailed methodology for calculating the potential consequences of future flooding, including a social index to express risks to social groups

In Latvia the methodology for the assessment of the consequences of future flood risk takes account of the following indicators:

1. Population in the flooded area;
2. Losses from economic activity and property;
3. Danger to social risk groups.

A special map is created for each indicator and then integrated into a combined map.

The damage to economic activity and property caused by the floods is monetary units for each type of land use (residential buildings, roads, agricultural land) per unit area (eg ha or m^2). The methodology includes formulae for the calculation of damage for each type of land use, for example for the calculation of damage to residential buildings the following formula is used:

$$Cost = S * V * F, \text{ where:}$$

S = area of the flooded building;

V = renovation costs per square meter;

F = damage factor value depending on the depth of flooding[14] (see table below)

Depth of flood, m	Damage factor
0	0
0 - 0.5	0.06
0.5 – 1	0.08
1 – 2	0.44
2 – 3	0.62
3 – 4	0.78
4 – 5	0.8
5 – 6	1

The threat to social risk groups is expressed using a social index related to the impact of the flood damage on the socially vulnerable groups in society.

The following statistical indicators are used in the calculation of social risk (% of total population in the administrative territory):

- population over 75 years of age,
- population under 15 years of age,
- population with chronic diseases,

[14] Taken from Kok M., 2001. Damage functions for the Meuse River floodplain. Internal report, JRC (Ispra)

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- disability,
- jobseekers / unemployed,
- residents in families forced to give up a car,
- people in families facing economic problems,
- average monthly income of the population (gross), euro,
- land area per capita, m^2

To optimize data analysis, indicators or criteria are divided into two large groups (see table below) where “max” are criteria that increase social risk and “min” are criteria that reduce the risk.

Risk indicators of socio-political aspects of floods

No.	Indicator	Administrative unit of data compilation*	Group of data for analysis
1.	Population over 75%	n	max
2.	Population under 15%	n	max
3.	Population with chronic diseases, %	r	max
4.	Disability, %	r	max
5.	Job seekers unemployed,%	n	max
6.	Residents of families forced to give up cars, %	r	max
7.	Population in families facing economic problems, %	r	max
8.	Average monthly income of the population (gross), euro	v	min
9.	Land area per capita, m^2	n	min

* - administrative unit in which statistics are available - county (n), region (r) or country

An equal weighting is assumed for all indicators in the assessment of potential social risk. The data are restructured into a matrix in which the element $\mathbf{X}_{ij}$ indicates the **i-**th alternative to **J**-th criterion (**J**= 1, 2 ..., m and **i**= 1, 2, ..., n). The methodology analyses m = 9 criteria (indicators) and n = 119 alternatives (administrative units). The data is transformed using vector normalization:

$$\mathbf{X}^*_{ij} = \frac{\mathbf{x}_{ij}}{\sqrt{\sum_{i=1}^{m} X^2_{ij}}}$$

$\mathbf{X}^*_{ij}$ **=** normalized j-th criterion of the i-th alternative. This value has [0; 1] interval.

To calculate the social index for each administrative unit, the criterion of "max" the amounts must be deducted from the sum of the "min" criteria:

$$\mathbf{y}^*_{ij} = \sum_{j=1}^{g} x^*_{ij} - \sum_{g+1}^{n} x^*_{ij}$$

Where:

g = 1 .., m = criteria that increase social risk;

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y^{*}_{ij} = aggregated social index.

The maximum value of the index indicates the largest loss in social terms.

The impact of floods on social risk groups is calculated using existing threats to the population in flooded areas and size of socio-political index:

$$S = \sum Pop\ (A, p) * \mathbf{y}^{*}_{ij}$$

Where:

S = number of people at social risk in the flooded area,

Pop (A, p) = population in the flooded area with area "A" in floods with "p" probability

Case Study 21 - Poland: Consideration of long term developments

Poland has assessed the effect of long-term developments on future flood risk by taking into account of two criteria: 1) the development of population density, 2) impact of spatial management with regard to the changes in built up areas (type of land use considered: rural, residential, industrial, transport infrastructure). The effect of long-term developments was assessed for fluvial floods with a mechanism of natural exceedance, for fluvial floods due to damage to flood prevention infrastructure, for pluvial floods, and for sea water floods. This type of analysis was not carried out for winter floods or for floods due to damage to damming infrastructure due to a methodology for such assessments not being available.

Case Study 22 - Poland: Assessment of flood risk as a result of damage to or destruction of a dam

An analysis of past floods resulting from the destruction or damage to dam structures was carried out which examined a total of 56 dams. It was concluded that historical floods resulting from damage to dams had not occurred. There is only one failure on record which took place during construction and it concerned the failure of a dyke and it was therefore concluded that its effects were not relevant to the analysis of floods resulting from the destruction or damage to damming structures. A further assessment of all dams was then carried out based on two criteria: the height of the dam is greater than 10 m; and a risk of flooding due to the failure of the dam has been identified in other projects. The extent of the likely flooding was assessed. Information for 25 reservoirs was obtained, and the number of buildings likely to be affected by the flooding was calculated and presented for each category of building. The analysis showed that in the areas at risk of failure of 26 dams, there are over 222 000.various types of facilities, of which

- 113 955 - buildings permanently inhabited by people,
- 83 345 - farm buildings,
- 12 192 - facilities employing people (enterprises, offices, etc.),
- 1 481 - schools, research institutions and hospitals,
- 1 294 - cultural facilities, museums and libraries,

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- 898 buildings in which people temporarily live (hotels and guesthouses),
- 470 - historic and religious buildings (churches and archaeological sites)

Twenty six reservoirs were identified as areas of significant flood risk as a result of the assessment, with one further reservoir identified for further consideration in the third cycle PFRA.

Case Study 23 – France: Assessment of the flood risk from dams

Nombre de barrages « pondéré »

Les barrages et digues (créés par l'homme) sont recensés dans le Système d'Information sur les Ouvrages Hydrauliques (SIOUH).

Les retenues naturelles (lacs naturels, moraines, etc…) ne seront pas traitées par cet indicateur, mais dans le chapitre « autres types d'inondations » du guide (séquence 13).

Justification de l'indicateur

Une digue est construite dans le but de protéger des enjeux d'une inondation. On peut donc considérer la présence de digues dans un territoire comme un indicateur de présence du **risque** d'inondation.

Les digues et les barrages sont aussi des sources potentielles de risque d'inondation en cas de rupture de l'ouvrage.

Données en entrée

- «Tronçons de barrages » ponctuels issus de SIOUH, classés (garder A et B) et cartographiés sous forme de points à partir des coordonnées du centroïde de l'ouvrage,
- Table des pavés de calcul.

Détail de la méthode

- A partir des barrages :
  - Pavé par pavé, compter le nombre de barrages ponctuels par classe,
  - Pavé par pavé, mesurer et sommer les proportions de longueurs de barrage linéaire[11] par classe,
  - 2 colonnes résultats : NbA[12], NbB.
- Faire le calcul des 2 indicateurs « intégrateurs » au pavé :

N_BARRAGE = NbA * 10³+NbB.

[11] proportion de longueur de barrage linéaire = longueur mesurée dans le pavé divisée par la longueur totale

[12] pour les barrages classe A : NbA = Nombre de barrages ponctuels dans le pavé + Somme des proportions de barrage linéaire dans le pavé

Machine translation:

Number of "weighted" dams

Dams and dikes (created by man) are listed in the Information System on Hydraulic Works (SIOUH).

Natural reservoirs (natural lakes, moraines, etc.) will not be treated by this indicator, but in the chapter "other types floods "in the guide (sequence 13).

Rationale for the indicator

A dike is built in order to protect the stakes of a flood. We can therefore consider the presence of dikes in a territory as an indicator of the presence of flood risk .

Dikes and dams are also potential sources of risk of flooding if the structure breaks.

Input data

"sections of dams" from SIOUH, classified (keep A and B) and mapped as points from coordinates of the centroid of the structure,

Table of calculation blocks.

Method detail

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From the dams:

- Pavement by pavement, count the number of punctual dams by class,
- Block by block, measure and sum the proportions of linear dam lengths[11] per class,
- 2 results columns: NbA[12], NbB.

Calculate the 2 "integrating" indicators on the pavement:

N_BARRAGE = NbA * 10^3+ NbB .

11 proportion of linear dam length = length measured in the paving stone divided by the total length

12 for class A dams: NbA = Number of point dams in the block + Sum of the linear barrier proportions in the block

Case Study 24 – Italy: Po RBD (ITB) Methodology for selection of APSFRs

The Po RBD (ITB) set out a clear methodology for the selection of APSFRs in a specific document[15]. The document includes the flow chart below outlining the process, and goes on to explain how the process should be applied, including details of how the specific criteria used should be calculated.

15 http://www.adbpo.it/PDGA_Documenti_Piano/PGRA2015/Sezione_A/Allegati/Allegato_3/Allegato_3_Relazione_ordinamento_e_gerarchizzazione_aree_a_rsichio.pdf

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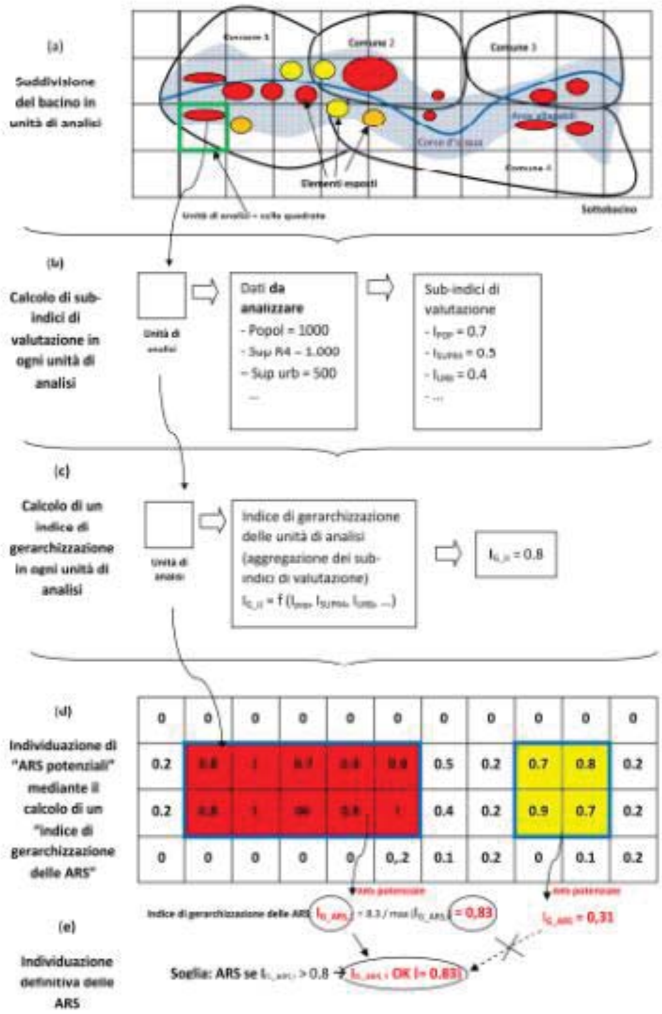

Figura 1 – Fasi della metodologia di lavoro per l'individuazione delle ARS: esempio relativo ad un sottobacino costituito da 4 Comuni, entro cui scorre un corso d'acqua che causa inondazioni, le quali vanno ad insistere su beni esposti a cui sono state attribuite classi di rischio (colori, nell'esempio) differenti. Nel caso in esame il sottobacino è stato suddiviso in unità di analisi costituite da celle quadrate appartenenti ad una griglia. Per ogni cella si calcola un "indice di gerarchizzazione delle unità di analisi" (IG_U). Le "ARS potenziali" sono individuate selezionando celle contigue il cui indice di gerarchizzazione IG_U è superiore ad una soglia stabilita (es. 0.7). L'individuazione definitiva delle ARS avviene calcolando un "indice di gerarchizzazione delle ARS" (IG_ARS) per ogni "ARS potenziale" e selezionando solo quelle il cui indice IG_ARS supera una soglia stabilita (es. 0,8).

Machine translation of figure title: Figure 1 - Phases of the working methodology for the identification of ARS[16]: example relating to a sub-basin consisting of 4 municipalities, within which flows a watercourse that causes flooding, which they insist on exposed goods to which risk classes have been assigned (colors, in the example) different. In the case in question, the sub-basin was divided into units of analysis consisting of cells squares belonging to a grid. For each cell a "hierarchy index of the unit of analysis "(IG_U). The "potential ARS" are identified by selecting contiguous cells whose indexIG_U hierarchy is higher than an established threshold (eg 0.7). The definitive identification of the ARS occurs by calculating an "ARS hierarchy index" (IG_ARS) for each "ARSpotential "and selecting only those whose IG_ARS index exceeds a set threshold (eg 0.8).

[16] ARS = APSFR

Case Study 25 – Austria: Criteria for the selection of APSFRs

Austria identified clear criteria and thresholds for the selection of APSFRs:

- impacted areas (populated or economically utilized) ≥ 60 ha;
- ≥ 200 impacted people per kilometre, on a length of at least 1.5 km, or fatalities solely due to the flooding event;
- damages (including infrastructure and cultural heritage) ≥ €5 million;
- disruption of drinking water supply through the contamination of protected areas for ≥ 1000 people; and
- significant ecological damages in protected areas ≥ 100 ha.

Case Study 26 – the Netherlands: Deltaprogramma

The Netherlands considered the IPCC scenarios for climate change impacts on flood risks. The outcomes of several projects that took into consideration these IPCC scenarios have been summarized under the so called 'Deltaprogramma'. This programme is an integral strategy to prepare the Netherlands for the consequences of climate change, higher and lower river discharges, changes in extreme precipitation, land subsidence and salinisation. The programme also takes into consideration socio-economic developments. The Deltaprogramma includes Delta scenarios on climate change, and these are used to identify and detect flood risks related to hydrological changes in an early stage. This is then further used in the cyclical evaluation of flood risk of infrastructures.

Case Study 27 – Croatia: Climate change modelling studies

The Croatian State Hydrometeorological Institute conducted a modelling exercise. The set of simulations was performed by the regional climate model for the period 1971 to 2070 at a spatial resolution of 12.5 km, and for the period 1971-2099/2100 at a spatial resolution of 50 km. The results of CMIP5 global climate models were used as boundary conditions: EC - EARTH, HadGEM2 - ES, CNRM - CM5 and MPI - ESM - MR. Until 2005, the global climate models and RegCM4 used measured greenhouse gas concentrations. For the period after 2005, two IPCC scenarios were used (RCP4.5 and RCP8.5) to simulate greenhouse gas concentrations. Simulations of the RegCM4 model were performed according to the recommendations and design of the CORDEX and EURO - CORDEX initiatives.

Based on the results of climate change modelling, it was concluded that the impact of climate change on flood risks is relevant throughout Croatia, and climate change should be carefully considered in all aspects of flood risk management. At the same time, the results of the model indicate that, in general, the adverse effects of climate change on flood risks increase: (1) from northeast to southwest and (2) on the coast where meteorological effects are superimposed with the effects of the sea level rise (which is also one of the predicted consequences of climate change). For the period 2011-2040 projections indicate possible warming in winter, spring and autumn from 1 to 1.3 ° C and in summer in most parts of Croatia from 1.5 to 1.7 ° C, and the results for the period 2041-2070 are even worse (1.7 - 2 ° C and 2,4 – 2.6 ° C). Further analyses of precipitation trends indicate a significant trend of increasing monthly precipitation for February in the whole of Croatia, and also a significant growing trend of maximum daily precipitation for February in HRJ.

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The spatial presentation of the impact of climate change is systematized on the map "Impact of climate change on flood risks"[17]. As part of the already established cooperation between the State Hydrometeorological Institute and Hrvatske vode, work continues on improving the interpretation of all previous knowledge on climate change, which will provide a more reliable assessment of the impact of climate change on flood risk management.

Case Study 28 – Portugal: Climate change models

The trend for high intensity rainfall over shorter periods leading to a greater occurrence of extreme events is acknowledged to pose increased risks either in the context of floods originating either from rainfall, due to insufficiencies in drainage systems in urban environments or from river floods, due to insufficient capacity for land drainage or as a result of difficulties in the management of the upstream hydraulic infrastructure. In order to take account of these predictions in the PFRA, the Portuguese Institute of the Sea and the Atmosphere (IPMA) developed scenarios of climate change in the various regions Portugal based on the results of multiple sets of climate models. These scenarios led to the development of indicators which could then be applied to the analysis of past floods. No information on the exact methodology used for the development or application of these indicators is provided in the PFRA.

Case Study 29 – Sweden: Climate change modelling

Sweden has used advanced and detailed modelling to incorporate climate change into its assessments. Modelling for the river basins, including climate change scenarios for the 100-year flood, has been carried out. The calculations are based on a method described in a report from 2011 by the Swedish electricity industry research group (Elforsk)[18]. Two exceptions are for the Torne river and the Göte river which do not have climate change projected 100-year floods. In the calculations different models and scenarios have been used in so called ensemble modelling for river basins in different parts of Sweden and used to generate different scenarios. Statistical calculations have then been conducted for periods of 30 years and the future 100-year flood calculated for these until 2098, showing an expected situation in 2100. The assessment includes, and maps on a dedicated online flood map portal[19] show, the extent of the flooded areas for the 100-year flood for the climate of the future. In addition, the 200-year flood scenarios considering climate change are included in the online map portal.

Case Study 30: Bilateral co-operation between Germany and the Netherlands on the EMS

As part of an exchange of letters between the competent ministers of the Netherlands government and the German Lander concerned, it has been agreed that the implementation of the Flood Risk Management Directive will be conducted in the same way as the implementation of the Water Framework Directive. This means that the information exchange and coordination on cross-border issues will take place in the international

[17] HR PFRA 2018, Section 3.5.1., Figure 50, p. 80. https://www.voda.hr/hr/prethodna-procjena-rizika-od-poplava-2018

[18] https://www.svk.se/siteassets/3.sakerhet-och-hallbarhet/dammsakerhet/rapporter-och-yttranden/elforskrapport-11-25-dimensionerande-floden-for-dammanlaggningar.pdf

[19] https://gisapp.msb.se/apps/oversvamningsportal/avancerade-kartor/oversvamningskartering.html

steering group Ems (ISE) and the international coordination group Ems (IKE) that are already in place (see figure below).

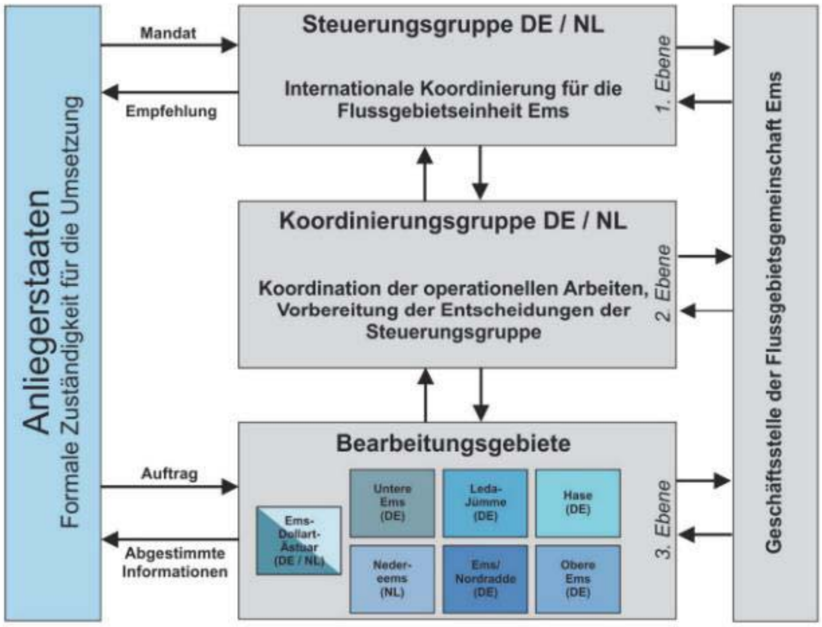

Abb. 3.1: Organisationsstruktur in der Flussgebietseinheit Ems

The ISE is responsible for the overall coordination and the general progress of work. This body makes the most important decisions on co-operation between the participating member states/federal states through meetings of the representatives of relevant ministries. The IKE consists of experts from the Netherlands, North Rhine-Westphalia and Lower Saxony. This body sets the fundamental resolutions of the inter-national steering group Ems and makes specific agreements about the joint implementation of the necessary operational work.

Case Study 31: Bilateral coordination between Belgium (Flanders) and the Netherlands on the Meuse and the Scheldt

Flanders and the Netherlands produced a short report describing how coordination has been achieved in the preparation of the PFRA and the identification of APSFRs. This includes a map showing the transboundary water bodies, and a table for each UoM showing where a flood risk is considered to exist.

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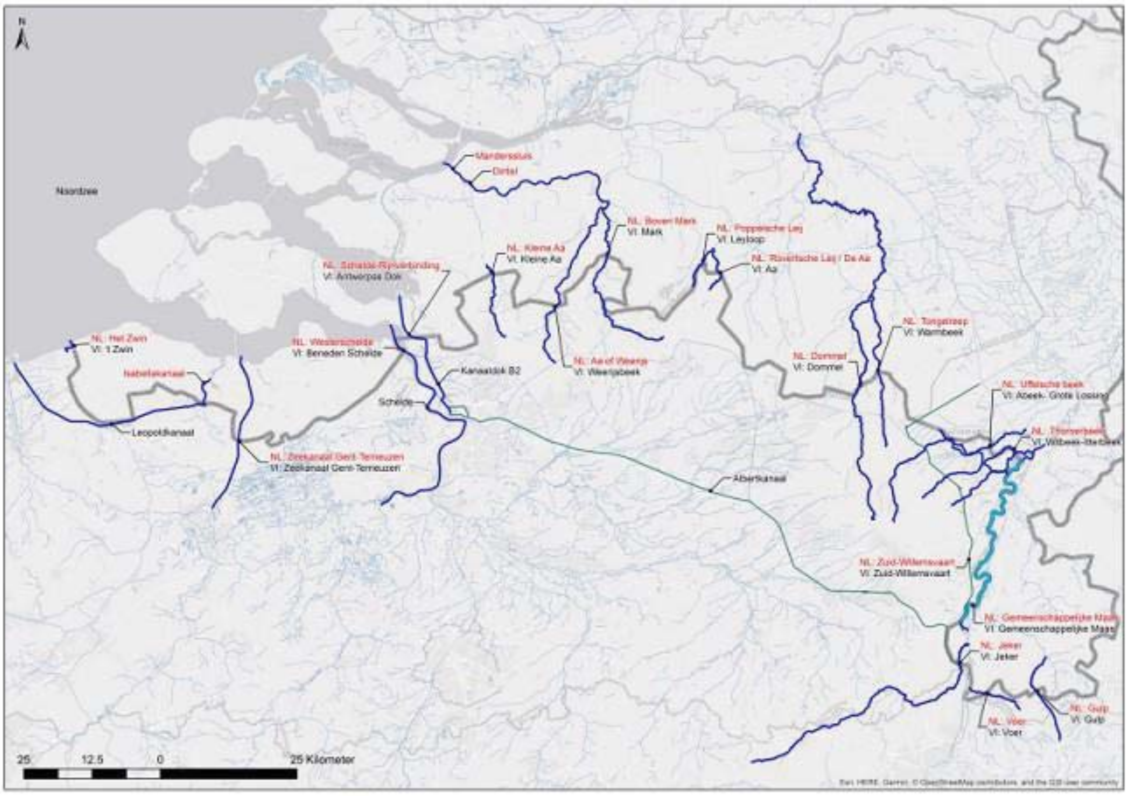
Kaart 1. Grensoverschrijdenden waterlopen tussen Vlaanderen en Nederland.



Tabel 1 met Vlaams-Nederlandse grensoverschrijdende wateren die aan Vlaamse of Nederlandse kant onder de ROR/ORL (tweede cyclus) vallen. Met "X" is aangegeven of het water meegenomen wordt.

Stroomgebied van de Maas

Vlaanderen	ORL2	Nederland	ROR2	opmerking
Gemeenschappelijke Maas	x	Gemeenschappelijke Maas	x	
Gulp	x	Gulp	x	
Voer	x	Voer	x	
Jeker	x	Jeker	x	
Itterbeek	x	Thornerbeek	x	
Abeek - Grote Lossing/ Uffelsche beek	x	Uffelschebeek	x	
Zuid-Willemsvaart		Zuid-Willemsvaart	x	
Warmbeek	x	Tongelreep		
Dommel	x	Dommel		
De Aa	x	Rovertsche Leij / De Aa		
Leyloop	x	Poppelsche Leij		
Merkske	x	Merkske		
Mark	x	Boven Mark		
Grote Aa/ Weerijsbeek	x	AA of Weerijs		
Kleine AA/ Wildertse Beek	x	Watermolenbeek		