European Commission

EU overview of methodologies used in preparation of Flood Hazard and Flood Risk Maps

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EU overview of methodologies used in preparation of Flood Hazard and Flood Risk Maps

Written by Steve Nixon
September 2015

EUROPEAN COMMISSION

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Summary

Context

Article 6 of the Floods Directive requires Member States to prepare Flood Hazard and Flood Risk Maps at the most appropriate scale for areas identified as being at risk of flooding by 22 December 2013. Article 15 requires the Member States to make available their flood hazard and flood risk maps to the European Commission by 22 March 2014. As of March 2015, all Member States, other than Bulgaria, had made available their maps and reported information on how they had been prepared; Greece had only provided information from one of their 14 units of management. It is expected that Bulgaria and Greece will conclude reporting on their FHRM by end of 2015 and by early 2016, respectively.

The standard approach of the Directive is for Member States to undertake a preliminary assessment of flood risk across their territories and use the results to identify Areas of Potential Significant Flood Risk based on available or readily derivable information. Member States were also able to use existing flood risk assessments if they were suitable for identifying areas at significant risk of flooding from all potential sources and in all parts of their territory. If existing risk assessments did not cover all potential significant sources of flooding or the whole country, then a new preliminary flood risk assessment was required for those specific flood sources and/or for areas/river basins not previously assessed.

Maps showing the hazards and risks from flooding are required for those areas identified as being at a significant risk of flooding. Some Member States already had existing maps and they were able to use these (if the information provided is equivalent to that described by the Directive) rather than producing new maps.

Mapping flood hazard and flood risk in Areas of Potential Significant Flood Risk

Areas of Potential Significant Flood Risk (APSFR) as required by Article 5 of the Floods Directive were reported to the Commission in March 2012. A comparison of the areas reported in 2012 with the areas for which maps were made available in 2014 shows that for many Member States flood hazard and flood risk maps were subsequently produced for most APSFR reported in 2012. However, in some cases there were differences in the numbers reported and in the sources of flooding associated with the risk areas. In most of these cases it is largely unapparent why areas identified by Member States in 2011 have not been subsequently mapped. It could be the case that some areas are no longer considered to be at risk of flooding or new areas may have been identified in between 2012 and 2014.

In the case of Spain some APSFRs have been grouped for modelling and mapping needs and in other cases during the mapping exercise it was considered appropriate to increase the number of APSFRs, especially those due to coastal flooding. This has resulted in an increase in the overall number of APSFRs identified from the PFRA in Spain and those subsequently reported with the flood hazard and risk maps. In Estonia two initially identified flood risk areas have not been mapped because of uncertainty in the determination of flood extents and probabilities.

It is recommended that the relevant Member States provide the Commission with an explanation of why some APSFRs identified in 2011 seem not to have been mapped or why the maps have not been made available to the Commission.

Sources of floods mapped

Member States are expected to prepare flood hazard and flood risk maps for all sources of flooding that have been assessed as being significant within their Units of Management: not all sources will necessarily be significant in all Units of Management. The most commonly mapped source is fluvial flooding with 25 of the 27 Member States reporting information preparing such maps. The two Member States (Luxembourg and Malta) that did not prepare maps for fluvial sources prepared maps (only) for pluvial flooding.[1] Four other Member States also prepared specific maps of pluvial flooding and eight other Member States combined pluvial flooding with other relevant sources (usually fluvial) in their maps. Seventeen of the 22 Member States with a coastline (that had reported), prepared maps of sea water flooding. Only two Member States prepared maps for groundwater floods and six for floods from artificial water bearing infrastructure.

In some cases, maps have not been reported or made available for sources of flooding for which APSFRs were reported in 2012. These include: pluvial floods in Germany and Hungary, groundwater floods in Ireland, Romania, and Slovakia; sea water floods in Romania; and, floods from artificial water bearing infrastructure in Hungary and Romania. This may be because for some maps the source of flooding is not always explicitly shown in the maps and all sources of flooding may have been combined into an overall flooding map. Also APSFRs may have been associated with more than one source of flooding and only one source (perhaps the most significant e.g. fluvial) may have been mapped.

Some Member State Authorities have subsequently explained the differences described above. In Hungary maps of pluvial flooding were not prepared because of a lack of available data and models, and floods from artificial water bearing infrastructure were no longer considered to be a significant hazard or risk. In Ireland maps of groundwater flooding were being prepared and would be provided at a later date. There was also no available data or

[1] Since the assessment of the maps took place, the LU authorities have clarified to the European Commission that it is in fact fluvial floods that have been included in the maps. The assessment was carried out on the basis that LU had mapped pluvial floods; the LU authority's notification regarding fluvial floods was received too late for relevant changes to be made within this report.

models for mapping seawater floods in Romania and there were no records of floods being solely from this source. In Slovakia pluvial floods are mapped in combination with fluvial floods. The explanation on the reason for not mapping groundwater and pluvial flooding in Romania was not clear and there was also no explanation on pluvial flooding in Germany. It is recommended that the situation is clarified with Member States.

Flooding scenarios

The Directive stipulates that as a minimum the hazards from low probability and medium probability flooding scenarios have to be mapped: a return period of 100 years or more is given for the medium probability scenario. Where thought appropriate by Member States, the hazards from a high probability flooding scenario should also be mapped. Member States also have the option of just mapping the hazards from low probability floods in coastal areas (where an adequate level of protection is in place) and from low probability groundwater floods.

All 25 Member States that had prepared and reported medium probability fluvial floods (Luxembourg and Malta only mapped pluvial floods[2] and Bulgaria had not yet reported) used a 100 year return period (as suggested by the Directive) or 1% annual exceedance probability for the expression of the probability of flooding: some also used other return periods such as 200 or 300 years. Most Member States that prepared and reported sea water flooding maps also used a 100 year return period or 1% probability for the expression of a medium probability scenario: Ireland used an annual exceedance probability of 0.5% and Italy either 50 or 200 year return period as well as 100 years.

Mapping of hazard elements

For each flooding scenario, as a minimum, flood extent and water depth or level have to be mapped. Where appropriate flow velocity or water flow may also be mapped. Most of the 25 Member States that have prepared fluvial flooding hazard maps show flood extents and water depths/levels for all three probability scenarios. The exceptions are Latvia where the publicly accessible maps only show flood extent and Denmark where the flooding probability scenarios are not shown on the maps. Twelve Member States also mapped flow velocity or relevant water flow for all three probability scenarios.

Luxembourg had mapped all 3 hazard elements on their pluvial flood maps whereas Malta only mapped medium probability pluvial floods that showed flood extent and water depth.

Thirteen of the 17 Member States preparing sea water flood maps produced hazard maps covering the two required probability scenarios and included the two required hazard elements. Water depth and flood extent were visualised on the Danish hazard maps but not in

[2] Since the assessment of the maps took place, the LU authorities have clarified to the European Commission that it is in fact fluvial floods that have been included in the maps.

relation to any specific scenario. Greece (one UoM only) did not prepare low probability maps because of the lack of available information; Slovenia used a combined measure of flood level and water flow velocity rather than the individual elements; and, Latvia mapped only flood extent in combination with fluvial floods. Five Member States also mapped flow velocity or relevant water flow for at least one of the three probability scenarios.

Resolution of maps

Accurate digital maps and digital elevation models are required to develop accurate representation of the extent and depth of flooding: this is particularly important if the potential adverse consequences of flooding are to be reliably identified and assessed. Four (at least in some of their UoMs) of the 17 Member States for which there was information on the vertical resolution of models used in flood mapping, and five (at least in some of their UoMs) of the 20 Member States with information on the horizontal resolution, did not meet the recommended practice for digital models used for flood mapping.

Scale of maps

Member States will determine the most appropriate scale of flood hazard maps and flood risk maps, and different scales can be chosen for instance depending on the area covered and type and purpose of the map. Maps intended to raise public awareness may require a larger scale than those used by national authorities for strategic planning. For most Member States (19) there was no information on how the most appropriate scale for the maps had been determined.

However, a check of the maps on national web pages and from information subsequently provided by Member State Authorities (except BG) indicated that 26 Member States had maps that had a scale of 1:25,000 or larger, indicating that they should be appropriate for public use. The maps for Hungary had a scale of 1 to 2,000,000 which seems to be inappropriate for public information and awareness purposes. There was no information for Bulgaria which has yet to report.

Mapping of potential adverse consequences

Maps should show at least the risks to potentially affected people, areas or aspects of economic activity, and, where present, installations which might cause accidental pollution should they be flooded, and other vulnerable features such as nature protection areas. The maps should be prepared covering the required and appropriate probabilities of flooding.

The information reported to WISE or through the qualitative checking of a subset of national maps or through additional information subsequently provided by Members States shows that:

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

- 27 Member States (excluding BG) reported/showed information on the potential adverse consequences on economic activity from medium probability floods;

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

- 13 Member States reported potential adverse consequences on cultural heritage: 7 others have also included cultural heritage features on their national maps.

Geo-referenced population census data or registers are commonly used to determine the number of potentially affected inhabitants within hazard areas. Building registers are also used and these can be used to estimate the numbers of occupants based on average occupancy rates, from the actual number of occupants per residence (e.g. based on water bill records) or generic assumptions on numbers of people for types of building or land use. Population density maps have also been used.

Numbers of potentially affected inhabitants have been provided by 25 Member States with the national maps reported to WISE. The maximum number of inhabitants potentially affected by medium probability fluvial floods in national APSFR varies from approximately 4.5 million in Hungary (HU only reported data for one (very large) APSFR covering the Danube River Basin District) to a thousand in Estonia. Excluding Hungary, the average number of potentially affected inhabitants in national APSFR is highest in France (31 thousand) and lowest in Croatia (50). Some Member States provided numbers of the potentially affected inhabitants at the scale of the UoM which are generally much larger in area than APSFR. Some UoMs may contain a number of specific flood risk areas. The values from the specific flood risk areas within a UoM may have been aggregated to derive a value for the UoM as a whole: the values for UoMs and APSFR are, therefore, likely to be not comparable. There are also likely to be differences in the methodologies used in calculating the numbers of inhabitants at risk which is also likely to affect the comparability of the values.

Member States were also asked to report (where relevant) the indicative number of people potentially affected during daytime and night-time, and the indicative number of transitory people potentially affected, for example, tourists likely to be in the location, visitors at campsites, etc. Only Italy (3 UoMs) and Sweden (6 UoMs) provided daytime information, Italy

(3 UoMs), Luxembourg (1 UoM) and Sweden (6 UoMs) night time information, and Italy (3 UoMs) and Sweden (1 UoM) transitory people information.

The Water Framework Directive Protected Areas (Article 7 drinking water abstraction areas, areas designated under the Bathing Waters, Birds, Habitats, Nitrate and Urban Waste Water Treatment Directives) most commonly reported to be at risk from the effects of medium probability fluvial flooding (e.g. pollution from flooded IED installations) were areas associated with the Habitats (14 Member States) and Birds (12 Member States) Directives. Ten (AT, CZ, DE, FR, HR, NL, PL, SE, SK, UK) of the 23 Member States that had reported information on potential adverse consequences on Protected Areas at the generic level did not specify which type of Protected Area might be adversely affected: Cyprus reported specific types of Protected Area but did not report at the generic level.

Justification for applying Article 6.6

For sea water flooding where there is an adequate level of protection in place, Member States can decide to limit the preparation of flood hazard maps to low probability or extreme events (Article 6.6). The Member States applying this Article are Germany (in 4 Units of Management) and Poland (2 Units of Management). Both Member States reported that they had assessed the risk of failure and adequacy of existing flood defences.

For Germany there was no direct statement as to what flooding probabilities the existing flood defences were considered to be adequate against. However, for two of the Units of Management only low probability maps were reported, whereas for the other two Units of Management medium and high probability floods were reported. For the latter two Units of Management the argument for the use of Article 6.6 is, therefore, unclear.

Poland produced low and medium probability flood maps but not high probability flood maps as existing defences protected the potentially affected areas.

Justification for applying Article 6.7

For groundwater flooding, Member States can decide to limit the preparation of flood hazard maps to low probability or extreme events (Article 6.7). The Member States applying this Article are Germany (3 Units of Management), Hungary and the UK (2 Units of Management). The justification for all three Member States was that flooding from groundwater was considered as only a contributory source rather than a main source of flooding and Hungary and the UK also indicated that it was difficult to distinguish the impact of groundwater flooding from other sources.

Application of Article 13.1.b in accordance with the requirements of the Floods Directive

Of the Member States applying this Article, the Netherlands and the UK seem to have met all the required provisions of the Directive whereas for other Member States (Belgium, Italy, Portugal and for some Units of Management in Germany) the meeting of some of the provisions is not clear and /or they are not applied to all flood risk areas, scenarios or all significant flood sources.

Slovakia has also applied this Article to 29 of the 355 APSFR in the Danube UoM. Slovakia also applied Article 13.2 to the same APSFR and the accordance of the maps with the requirements of the Floods Directive has been assessed in relation to Article 13.2 (see next section).

Compliance of the use of Article 13.2 with the requirements of Article 6

Article 13.2 has been applied in 4 Units of Management in Germany (other Articles are also applied in these Units of Management) and in Slovakia (for 29 specified APSFRs in the Danube RBD out of the 355 previously reported in 2012).

It is not clear from the reported information whether the use of Article 13.2 in the 4 Units of Management in Germany provides a level of information equivalent to the requirements of Article 6. It could not also be confirmed from the available information that the maps for APSFRs covered by Article 13.2 in Slovakia fully meet the requirements of Article 6.

Preparation of flood hazard and flood risk maps in international UoMs

Article 6.2 of the Floods Directive requires that the preparation of flood hazard maps and flood risk maps for areas identified under Article 5 (Areas of Potential Significant Flood Risk) which are shared with other Member States should be subject to prior exchange of information between the Member States concerned.

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

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

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

Recommendations

There are several gaps in the availability of information on some Member States' flood maps. Bulgaria has not reported as of yet, Greece has only reported for one Unit of Management and data from Croatia, Malta and Portugal has yet to be added to the WISE database. It is recommended that these information gaps are filled as soon as possible so that a complete EU overview can be obtained in the future, particularly with regards to the importance of mapping in the next step in the implementation of the Floods Directive, i.e. the preparation of flood risk management plans by 22 December 2015.

A sub-set of national maps were selected for checking on national servers to reflect any differences in the application of the relevant Articles within a Member State and also the sources of floods that had been reported to be associated with APSFR identified under Article 5. It is not clear from the selection of maps checked on national web pages or from the maps reported to WISE why some Areas of Potential Significant Flood Risk identified by Member States in 2011 under Article 5 or Article 13.1.a do not appear to have been mapped. It is recommended that the Commission seeks clarification from the relevant Member States on this issue.

It appears that some sources of flood associated with APSFRs identified under Article 5 or Article 13.1.a have not been subsequently mapped. Some of the cases found have been subsequently clarified by the Member States concerned following a review of an earlier draft of this overview report. Further clarification is required in terms of the apparent non-inclusion of pluvial floods in the maps in Germany, and for the apparent non-inclusion of groundwater floods and floods from artificial water bearing infrastructure in the maps in Romania.

Hungary has produced maps at a scale that apparently does not meet best practice criteria for maps intended for public information and awareness raising. This should be confirmed with the relevant Member State and in particular whether smaller scale maps have been produced that may be more appropriate for public use.

The justification for the application of Article 6.6 in two Units of Management in Germany is not clear. This needs to be clarified with the Competent Authority.

It is not clear whether the application of Article 13.1.b in Belgium, Italy, Portugal and for some Units of Management in Germany is in full compliance with the requirements of the Floods Directive. This issue needs to be raised with the respective Member States by the European Commission.

It is not clear whether the application of Article 13.2 in some units of management in Germany and for some APSFR in Slovakia is in full compliance with the requirements of Article 6. This issue needs to be raised with the respective Member States by the European Commission.

Twenty six Member States share river basins with another Member State. It is not clear from the available information as to whether there are shared flood hazard and flood risk areas within these shared basins. There is exchange of information in 15 Member States sharing flood risk areas but the situation with regards to 9 other Member States in terms of the presence or not of shared flood risk areas and, if there are, as to whether there has been prior exchange of information on mapping, needs to be determined. Two Member States with shared basins indicated that they have no shared flood risk areas.

1. Context

Article 6 of the Floods Directive requires Member States to prepare flood hazard maps and flood risk maps:

- **flood hazard maps** should cover the geographical area which could be flooded according to different probabilities, along with some hazard related information associated to those areas;

- **flood risk maps** should show the potential adverse consequences associated with floods under these probabilities, relating to human health, economic activity, the environment and cultural heritage.

These maps must be prepared at the river basin district or unit of management (UoM) level and at the most appropriate scale (Article 6.1):

- for the Areas of Potential Significant Flood Risk (APSFR) identified under Article 5 or according to Article 13.1.a, or

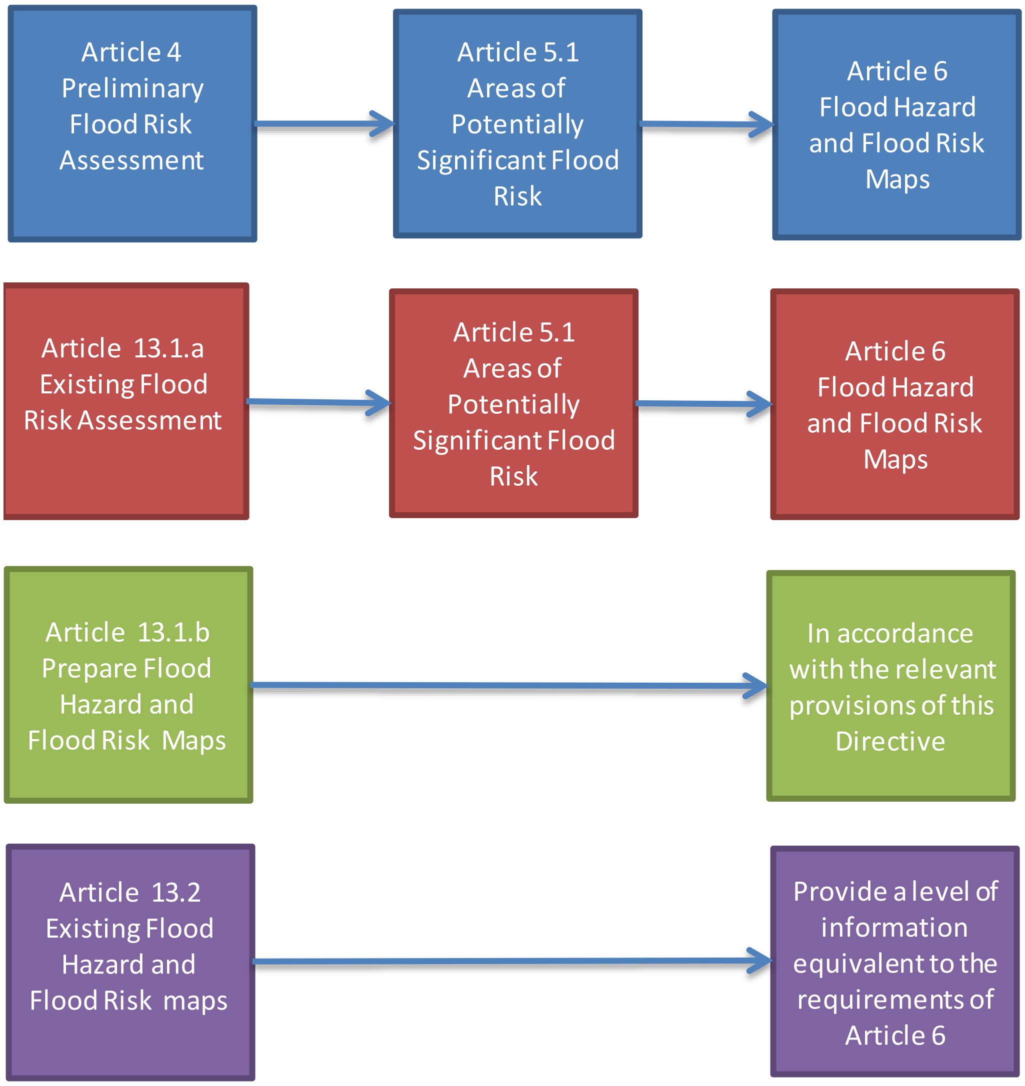
- for the areas for which Member States decide to prepare flood maps according to Article 13.1.b.

Member States may also make use of maps finalised before 22 December 2010 (Article 13.2) as long as they provide a level of information equivalent to the requirements of Article 6.

Member States will determine the most appropriate scale of flood hazard maps and flood risk maps, and different scales can be chosen for instance depending on the location and type and purpose of the map.

The various possibilities for Member States preparing flood hazard and flood risk maps and subsequently making them available to the Commission by 22 March 2014 are illustrated in Figure 1.1. Annex 1 shows how Member States have applied the different Articles relating to the assessment of flood risk.

Figure 1.1 Illustration of the various options for Member States preparing Flood Hazard and Flood Risk maps



Member States are entitled to fulfil the Directive's requirements by publishing maps on their own portals. However, the Commission is required to assess the compliance of flood hazard maps and flood risk maps with the requirements of Articles 6 and 13.2. This was to be facilitated by the use of electronic schema through which Member States were asked to submit to the Water Information System for Europe (WISE) specific information defined in Reporting Sheets endorsed by the Water Directors.

There are two schema:

- LinkToMS: with links to locations where national maps can be viewed;
- FHRM: comprising two main components:
    - Summaries of the methodologies used for the preparation of the maps;
    - FloodHazardMaps with data related to the content of the national maps (at least for the medium probability scenario) that can be used with the visualisation of the maps at the European scale on the WISE Floods Viewer. As of June 2015, the following 27 Member States had provided this information:

Austria	Germany	Netherlands
Belgium	Greece [1]	Poland
Croatia	Hungary	Portugal
Cyprus	Ireland	Romania
Czech Republic	Italy	Slovakia
Denmark	Latvia	Slovenia
Estonia	Lithuania	Spain
Finland	Luxembourg	Sweden
France	Malta	UK

[1] One UoM reported

    - Member States were also required to report spatial information either as Geography Markup Language GML files or as shape files that would enable summary maps to be produced at European level. As of June 2015, the following 15 Member States had provided this information:

Austria	Greece [1]	Malta
Croatia	Hungary	Poland
Cyprus	Ireland	Romania
Czech Republic	Italy	Slovakia
Germany	Lithuania	Sweden

[1] One UoM reported

This report provides an overview of the methods applied by Member States. It is primarily based on:

- a qualitative check of a selection of Member States' flood hazard and flood risk maps located on national servers and/or web pages (accessed through the LinkToMS schema);

- summary information reported by Member States on the methods used in the preparation of their maps (reported in the FHRM schema); and,

- the data related to national maps (reported in the FHRM schema).

Data from the schema are made accessible and useable for the purposes of this type of assessment via online reports and a database. The latest version of the database used to inform this report was created on 13 August 2015.

This report does not include in-depth assessment of national background methodological reports which may have been referenced in Member States reports and/or provided with their electronic reports.

Where relevant and appropriate, it also contains clarification and additional information on particular aspects provided by Member States following their review of an earlier draft of this overview report. In one particular instance, however, subsequent to the assessment the LU authority clarified that they had in fact mapped fluvial floods, not pluvial floods. The assessment had been carried out on the basis that LU had mapped pluvial floods; the LU authority's notification regarding fluvial floods was received too late for relevant changes to be made within this report.

2. Mapping of Areas of Potential Significant Flood Risk

Areas of Potential Significant Flood Risk (APSFR) were expected to have been identified under Article 5 by those Member States applying Article 4 and/or Article 13.1.a to the whole or part of their territories and/or for all relevant significant sources of flooding. The APSFR are the end point of Article 4 Preliminary Flood Risk Assessment required to be completed by December 2011 or to be identified using existing flood risk assessments.

Article 6.1 requires Member States to prepare flood hazard maps and flood risk maps for the APSFR at the most appropriate scale to be determined by the Member States.

There may be reasons why maps have not been prepared for all those areas identified by the end of 2011, for example the areas may no longer be considered at significant risk or at risk from a particular source of flooding. Alternatively additional APSFR may have been identified since the first assessment.

Table 2.1 compares the APSFR reported under Article 5 and associated with the application of Articles 4 and 13.1.a (APSFR schema), in the links to national maps schema (LinkToMS schema) and the Flood Hazard Risk Maps schema (FHRM schema).

As of August 2015, 8,266 APSFR from 23 Member States had been reported in the Article 5 schema (APSFR.XML). Croatia (HR) reported the most APSFR (2,976).

For some Member States (e.g. AT, PL, SI and UK) there is good correspondence between the numbers reported in each of the three schema which means in principle that all those areas identified under Article 5 should be viewable within maps on national web pages.

A number of Member States (DK, ES, HU, LU, LV, RO, SK) have identified and reported APSFR under Article 5 and also in the FHRM schema but have not provided any links to national sources that go straight to maps of each of these APSFR areas: those for Spain should be viewable using the link to a national web viewer and searching for the APSFR. The reporting of APSFR by Germany is particularly complex with large differences in numbers and codes of APSFR between the three schemas.

Member States were asked to report a unique EU code for each of the APSFR identified under Article 5. National names of each APSFR were also reported. The number of unique codes per Member State is assumed to equate to the number of APSFR identified. There are also significant differences in the number of APSFR codes reported in 2012 with the preliminary flood risk assessment and those reported in 2014, particularly in DE, ES, FR, HR, RO and SK. Reasons for these differences were sought from the methodological information provided by Member States in the FHRM schema. However, there was not always an explanation for the observed differences.

In Germany all types of floods have been assessed but only fluvial and coastal floods have been considered in the later process. In the 2012 preliminary flood risk assessment, pluvial floods were also reported for some APSFR: it is not clear why maps were not prepared for pluvial floods.

Initially 20 APSFR were designated on the territory of Estonia: maps were subsequently prepared for 18 areas in 2014: 13 APSFR were reported in the LinkToMS XML. Two areas which were considered to be significant flood risk areas in 2012 have not been mapped. This was because in one area the actual extent and probabilities of flooding were unclear. For the city of Kohtla-Järve, the explanation for not preparing flood maps for the APSFR was because the main source of flooding was a combination of pluvial sources and failures in the artificial water-bearing infrastructure which led to uncertainty in the extent and probability of the floods.

In Spain several (7) UoMs have reported a grouping of previously foreseen APSFRs which might explain the decrease in the number of APSFR codes reported in the FHRM schema from those reported under Article 5 in 2012.

Flood hazard and flood risk maps have been prepared for the 21 areas in Finland identified in the preliminary flood risk assessment in 2012: these maps became available in January 2014 with the launch of the map-service. Flood hazard maps have also been prepared for 80 additional areas which have not been designated as APSFR (i.e. there is no significant flood risk) and might, for example, be used for land planning purposes.

A number of reasons for the differences in the number of APSFR identified and subsequently mapped were given by Romania. For example, the APSFR identified as being at risk from flooding from sea water have not yet been mapped because the research and mathematical modelling required for the mapping have yet to be undertaken or developed. In addition, all 23 APSFR that represent parts of Danube floodplain were embedded into one area along the Danube; 2 other areas were merged because the associated flooded area in case of dike failure are the same in terms of flood extent and water depth; and, in other cases it was not possible to model the flood hazard separately and some areas were merged.

In Croatia the available flood hazard and flood risk maps are to be further modified up until the end of 2015 to reflect the findings of the public consultation and further hydrological - hydraulic analysis.

Table 2.1 Comparison of the APSFR codes reported in the APSFR schema, LinksToMS schema and the FHRM schema

MS	According to Article 5			Within LinkToMS			In the FHR Maps		
	APSFR Codes	Not in LinkToMS	Not in FHRM	APSFR Codes	Not in Article 5	Not in FHRM	APSFR Codes	Not in Article 5	Not in LinkToMS
AT	391	3	3	388			388		
BE									
BG	116	116	116	NR			NR		
CY	19			19			19		
CZ	269	269	269						
DE	973	134	562	412	1	1	839		428
DK	10	10					10		10
EE	20	7	6	13	0	6	14	0	7
EL	124	121	121	3[a]			3[a]		
ES	1320	1320	412				1190	282	1190
FI	21			21			21		
FR	146	28	29	125	7	5	120	3	0
HR	2976	2976	2976				2455	2455	2455
HU	2	2	2				1	1	1
IE	300		250	300		250	50		
IT									
LT	129	129	129						
LU	15	15	15				15	15	15
LV	25	25	16				12	3	12
MT	0			0			4	4	4
NL									
PL	268	1	1	267			267		
PT									
RO	399	399	29				371	1	371

MS	According to Article 5			Within LinkToMS			In the FHR Maps		
	APSFR Codes	**Not in LinkToMS**	**Not in FHRM**	**APSFR Codes**	**Not in Article 5**	**Not in FHRM**	**APSFR Codes**	**Not in Article 5**	**Not in LinkToMS**
SE	18	5		13			18		5
SI	61			61			61		
SK	383	383					520	137	520
UK	281			282	1	1	281		
MS	23	18	16	12	3	5	21	9	12
Total	8266	5943	4936	1904	9	263	6659	2901	5018

Member States highlighted in blue are those that have applied Article 13.1.b and hence do not need to identify APSFR during the first PFRA phase under the Directive. However, in order to prepare maps in accordance to the provisions of the Directive the MS must have identified some areas of flood risk around which to build scenarios and maps.

Based on data available on 14 August 2015.

Note that some Member States have updated their APSFR since they were first reported to the Commission in 2012.

NI = no information; NR = not reported, a = EL only reported one UoM (GR12)

3. Sources of floods that have been mapped

Maps showing the hazards and risks of flooding should have been prepared and made available to the public by December 2013. The maps should show at least the hazards and risks to potentially affected people, areas of economic activity, and, where present, installations which might cause accidental pollution should they be flooded, and other vulnerable features such as nature protection areas. Maps should be prepared covering a range of different probabilities of occurrence of flooding events (e.g. those with low, medium and high probabilities).

Table 3.1 summarises the sources of floods that have been mapped by Member States. The table has been compiled from:

- Data reported to WISE in the FHRM schema on the sources of floods included in flood hazard and flood risk maps: the FHRM columns in the table give the number of UoMs where data for maps for each source has been reported;

- Sources described in the methodological summary information reported in the FHRM schema; and,

- Flood sources found on the checked examples of maps on national servers accessed via links reported in the LinkToMS schema.

The hazard and risk from relevant sources of floods can be visualised in different ways across and within Member States. For example there can be separate standalone maps for specific sources or separate layers within a GIS application or more than one source can be distinguished on the same map: these cases are indicated as “Yes” within the “specific map” columns in the Table.

Some Member States may have assessed the hazard and risk from all relevant sources and combined the outcome on a flood map that does not differentiate between the assessed sources. These cases are indicated as “Yes” within the “combined map” columns in the Table.

Member States may have also produced specific maps within some UoMs but combined maps within other UoMs.

Information on whether source-specific or combined source-maps have been prepared has been obtained from the reported methodological summary information and from the qualitative checking of examples of maps on national servers as described above. As previously described, a draft of this overview report was reviewed by Member States: relevant comments have also been taken into account in Table 3.1.

Table 3.1 Summary of sources of flooding for which flood maps have been prepared by Member States

MS	Source not reported	Fluvial			Pluvial			Groundwater			Seawater			AWBI			Main rivers and sea
	FHRM (UoM)	FHRM (UoM)	Specific map	Combined map	FHRM (UoM)	Specific map	Combined map	FHRM (UoM)	Specific map	Combined map	FHRM (UoM)	Specific map	Combined map	FHRM (UoM)	Specific map	Combined map	FHRM/ Combined
AT		2	Yes			Yes											
BE	2	5	Yes		1	Yes		1	Yes				**Yes**	1	Yes		
BG	Not reported to WISE																
CY		1	Yes														
CZ		3	Yes														
DE		10	Yes								7	Yes					
DK				Yes							2	Yes					
EE		1		Yes	1		Yes				1		Yes				
EL		1	Yes								1	Yes					
ES		21	Yes		1		Yes			Yes	22	Yes					
FI		6	Yes								2	Yes			Yes		
FR		12	Yes		3		Yes				9	yes					
HR		2		yes							1		Yes			Yes	
HU		1	Yes					1	Yes								
IE		10		Yes							5		Yes				
IT		47	Yes		1	Yes					26	Yes		1	Yes		
LT		4	Yes				Yes				2	Yes			Yes		
LU					1	Yes											
LV		1	Yes								1		Yes				
MT					1	Yes											
NL		4		Yes			Yes						Yes			Yes	
PL		3	Yes								2	Yes					
PT		8	Yes														
RO		12		Yes	3		Yes										
SE	6		Yes												Yes		
SI		2		Yes			Yes				1	Yes				Yes	
SK		2		Yes	1		Yes			Yes							
UK		5	Yes	Yes	12	Yes					5	Yes	Yes	11	Yes		11

EL Based on 1 UoM only

Land locked

Most Member States (25) have published maps on fluvial flooding**Error! Reference source ot found.**. There is no specific distinction made between sources of flooding in the maps prepared by Belgium, Croatia, Denmark, Estonia, Ireland, the Netherlands, Romania, Slovenia, Slovakia and the UK (for some UoMs) though these Member States (other than Denmark and UK for some UoMs) reported data on fluvial floods to WISE which can be used to visualise national flood maps on EU-scale maps. Malta and Luxembourg only mapped pluvial floods[3] and Bulgaria had not reported by March 2015. Potential flooding from the failure of water bearing infrastructure has been mapped in some areas of Belgium, Finland, Italy, Lithuania, Sweden (dams for hydropower electricity plants), and in the UK (reservoirs). Emergency Action Plans (*Planes de emergencia de presas*) for big dams in Spain include the flood-prone areas for different scenarios of dam failure but as the likelihood of dam breakage is considered to be very low, there are no APSFRs designated in Spain and flood maps have not been prepared for this flood source and mechanism. Other than Cyprus, Malta, the Netherlands, Portugal, Romania and Sweden, all Member States with a coastline (and having provided information) have prepared specific maps on sea water flooding. The Netherlands prepared maps of flooding that did not differentiate between sources even though all relevant sources (including seawater) were assessed in the preparation of the maps.

The sources of the floods associated with the APSFR identified by a preliminary flood risk assessment and as required by Article 5 were to be reported by Member States by March 2012. A check was made to see if the sources were subsequently mapped for the relevant APSFR. Examples of the Member States that identified APSFR under Article 5 but seemingly hadn't subsequently mapped all the associated sources of flood were:

- Germany identified pluvial floods to be associated with APSFR but this source was not subsequently specifically mapped: the reason for this is not known.

- Spain, groundwater: There was only one groundwater APSFR in ES010 RBD, and here flooding was combined/mapped with fluvial flooding.

- Hungary identified APSFR associated with pluvial floods and floods from artificial water bearing infrastructure. Hungary seems to have defined flash floods in small rivers as pluvial floods for the PFRA. Pluvial (flash flood) hazard maps were not prepared by 2014 because the required detailed survey of the significant creeks had not been finalised and so it was not possible for the hydrodynamic models to provide sufficient results. The failure of artificial water-bearing infrastructure (reservoirs gates and other structures) because of their size does not generate water related damage in the considered probability scenarios and were therefore not investigated further in the mapping work.

[3] Since the assessment of the maps took place, the LU authorities have clarified to the European Commission that it is in fact fluvial floods that have been included in the maps.

- Ireland identified APSFR associated with groundwater: maps of groundwater flooding are being prepared and will be provided at a later date.

- Romania: groundwater, seawater and artificial water bearing infrastructure. Romania has indicated that they have neither the research nor models to map the hazards from sea water floods and there are also no records of flooding being solely caused by seawater. The Romania Authorities subsequently stated that they have not designated any APSFR having pluvial or groundwater as the main flooding source. Two APSFR have as a flood mechanism “Defence or infrastructural failure”; these 2 APSFRs could be symbolised in a specific way: these specific cases were not specifically checked in this assessment.

The following sections describe in more detail the data associated with, and methods used to prepare, flood maps of the different sources of floods.

4. Methodologies used to prepare flood hazard maps

Article 6.3 of the Floods Directive requires Member States to prepare flood hazard maps covering the geographical areas which could be flooded according to the following scenarios: (a) floods with a low probability, or extreme event scenarios; (b) floods with a medium probability (likely return period ≥100 years); and (c) floods with a high probability, where appropriate. For each scenario the following elements should be shown: (a) the flood extent; (b) water depths or water level, as appropriate; and (c) where appropriate, the flow velocity or the relevant water flow (Article 6.4).

The following sections summarise the methods reported to be used by Member States in the preparation of their flood hazard maps. There are separate sections for fluvial, pluvial, groundwater and sea water floods, and for floods from artificial water bearing infrastructure. As most Member States have mapped fluvial floods, the most extensive and detailed information is for fluvial floods. The focus of this chapter is therefore on fluvial floods. Some of the methods used for fluvial floods will also have been applied to the mapping of floods from other sources within a Member State.

4.1 Fluvial floods

4.1.1 Expression of probabilities for flood scenarios

Table 4.1 summarises the numeric values of the probabilities used by Member States for each of the scenarios mapped for fluvial flooding. The information is illustrated in Figure 4.1. Where a range of values are shown this reflects differences between UoMs within the Member State.

Table 4.1 Summary of scenarios mapped for fluvial flooding with associated expressions of probabilities

MS	Low Probability		Medium Probability		High Probability	
	Return Period (years)	Percentage probability	Return Period (years)	Percentage probability	Return Period (years)	Percentage probability
AT	300		100		30	
BE	100 to 1000		25-50 or 100		10	
BG	Not reported					
CY	500		100		20	
CZ	500		100		20	
DE	200, 1000		100		10, 20, 25, 30	
DK	1000		100		20	

MS	Low Probability		Medium Probability		High Probability	
	Return Period (years)	Percentage probability	Return Period (years)	Percentage probability	Return Period (years)	Percentage probability
EE	1000		100		10 to 50	
EL	1000		100		20; 50	
ES	500		100		10	
FI	1000		100		50	
FR	1000		100 to 300		10 to 30	
HR	1000		100		25	
HU	1000		100		30	
IE		0.10%		1%		10%
IT	300-500		100-200		30	
LT	1000	0.10%	100	1%	10	10%
LU	Fluvial floods not mapped					
LV		0.50%		1%		10%
MT	Fluvial floods not mapped					
NL	1000		100		10	
PL	500	0.20%	100	1%	10	10%
PT	1000		100		20	
RO	1000		100		10 or 30	
SE	10000		100		50	
SI	500		100		10	
SK	1000		100		5 to 50	
UK	1000		100 to 200	1% (1)	10 to 30	

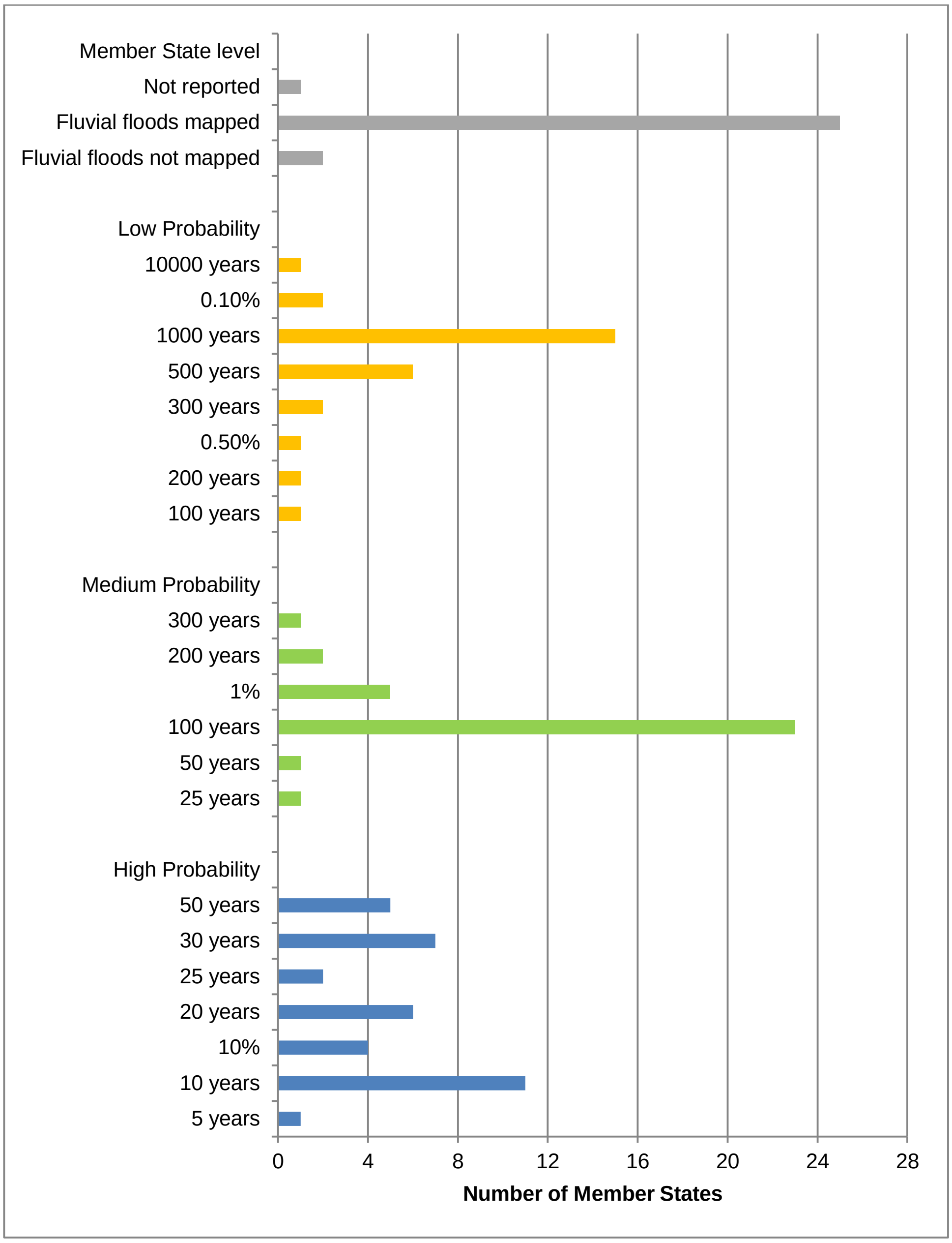
Note: information from EL is for only one UoM (GR12)

1. Main river and sea floods in England and Wales

The LU authorities subsequent to the assessment of maps stated that fluvial floods had been mapped. Only pluvial floods were reported to WISE.

A review of the methods used by (25) Member States in preparing their flood maps shows that most of them used a 100 year return period (or 1 % probability) for mapping the medium probability events (Figure 4.1). A range of probabilities from 0.01% to 0.5% (16 Member States use 0.1% or a 1000 year return period) were used for extreme events, and a range of probabilities from 5 to 50 year return periods for the high probability, relatively common events.

Figure 4.1 Number of Member States applying different expression of probabilities (return periods in years and percentage probability of occurrence) for the different probability scenarios for fluvial flooding



Note that more than one expression of probability may apply to each scenario mapped.

4.1.2 Hazard elements

Article 6.4 of the Floods Directive states that:

"For each scenario referred to in paragraph 3 the following elements shall be shown:

(a) the flood extent;

(b) water depths or water level, as appropriate;

(c) where appropriate, the flow velocity or the relevant water flow."

Table 4.2 summarises by Member State, and Figure 4.2 provides an EU overview, of the hazard elements for each of the mapped flooding scenarios.

Table 4.2 Elements included in the hazard maps of fluvial flooding

MS	Flood extent			Water depth/level			Flow velocity or the relevant water flow		
Scenario	Low	Medium	High	Low	Medium	High	Low	Medium	High
AT	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
BE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
BG (NR)									
CY	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
CZ	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
DE	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
DK	No	No	No	No	No	No	No	No	No
EE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
EL	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
ES	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
FI	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
FR	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HR	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
HU	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
IE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
IT	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
LT	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
LU	Fluvial not mapped			Fluvial not mapped			Fluvial not mapped		
LV	Yes	Yes	Yes	No	No	No	No	No	No
MT	Fluvial not mapped			Fluvial not mapped			Fluvial not mapped		
NL	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
PL	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
PT	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
RO	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
SE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SI	Yes	Yes	Yes	No	No	No	No	No	No
SK	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
UK	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes:

BG: Not reported

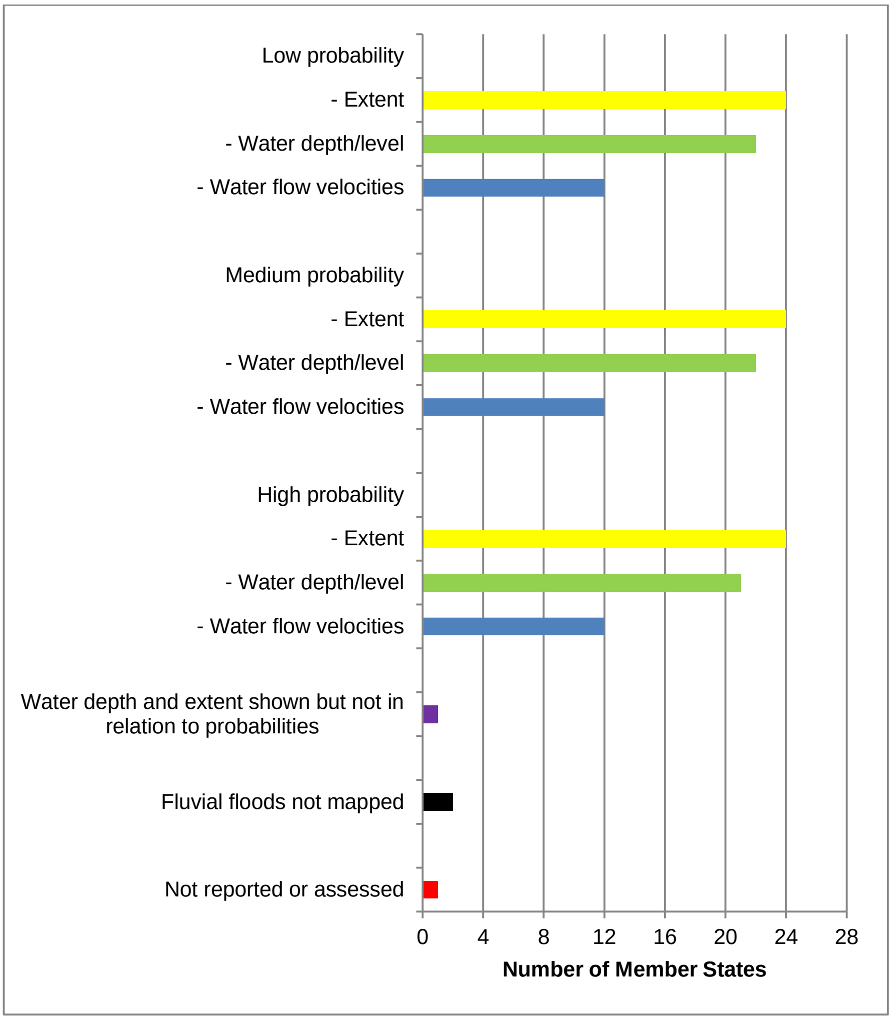
DK: Water depth and extent shown on maps but not in relation to probabilities

LU, MT: Fluvial not mapped*

SI: combination of water depth and velocity at specific water flow included

* The LU authorities subsequent to the assessment of maps stated that fluvial floods had been mapped. Only pluvial floods were reported to WISE.

Figure 4.2 Number of Member States including the different elements in their hazard maps for fluvial flooding



All those Member States mapping fluvial floods show flood extent on their maps. However, in the case of Denmark this is not shown in relation to flooding probabilities. In the case of water depth or level, two Member States (Latvia and Slovenia) do not show this element on their maps though Slovenia uses a combination of water depth and velocity instead. Water flow velocity is only shown on the fluvial maps of 12 Member States. In general most of the 25 Member States with fluvial flood maps show flood extents and water depths/levels for all three probability scenarios: the exception is Denmark where flooding probabilities are not shown.

Most Member States are, therefore, meeting the requirements of the Floods Directive in that they have produced maps of low and medium probability fluvial flooding that show flood extent and water depth or levels.

4.1.3 Calculation of return periods and probabilities for fluvial floods

Table 4.3 summarises the main approaches to the calculation of return periods and probabilities associated with each of the required scenarios stipulated by the Floods Directive. The summary is based on the information on methodologies reported to WISE by Member States.

Table 4.3 Summary of approaches used in the calculation of return periods and probabilities for fluvial floods

Approach	Member State
Expert judgement	BE (BXL), HR, NL, SE
Historical data	AT, BE, CZ, DE, FI, FR, IT, LT, LV, NL, PL, SE, SK
Statistical analysis	AT, BE, CZ, EE, EL, FI, HU, HR, IE, IT, LT, LV, NL, PL, RO, SE, SI, SK
Modelling	BE, DE, ES, HR, HU, IT, NL, PL, RO, SE
Hydrological rainfall-runoff models	CY, EL, ES, HR, IE, IT, NL
Hydrological studies	ES, FR, IE, IT, NL
No information	DK, PT, UK

In the case of Belgium (Flanders) historical storm data with statistical analysis was used in the calculation of return periods and probabilities for fluvial floods. In Brussels the calculation of high probabilities was based on testimony from local water managers, medium probability was based on rainfall statistics, and for low probability, information was from inventories of flood events covering over a century. In Cyprus intensity-duration-frequency rainfall curves were used: these were based on data for the period after 1970 (in order to take into account recent climate change). Statistical analysis of river discharges was also undertaken in the Czech Republic with the significant impact of dams on discharge being eliminated from the calculations. In Germany the return period was calculated from long term measurements (no length provided) according to a national approach for medium probability scenarios: the approach for low and high probabilities was mainly based on modelling.

The periods and probabilities of floods were calculated in Estonia from the representative measurement series from the available hydrometeorological observation data. The length of the measurement series was in most cases more than 30 years (minimum 19 years and maximum 144 years). Based on these observation data an empirical excess probability curve and its parameters were determined. Based on these parameters a distribution function was found to draw up the theoretical curve (distribution function chosen according to the area). Based on this, a theoretical excess probability curve was constructed and on the curve the excess water levels were detected. The results were transferred to specific areas.

In Lithuania all available data from the river gauging stations were used for the calculation of probabilities of flooding. The length of the measurement series was different at each station (the longest time series was between 1812 and 2010 and the shortest was between 1986 and 2010). In Slovakia return periods and/or probabilities were calculated by statistical analyses of hydrological data covering at least 20 years.

In Hungary statistical analysis was also used to determine the different return periods' flooding characteristics (water level and discharge) and related time series, and these values were applied in 1D and 2D hydraulic models.

In Spain, geomorphological and historical information was initially compiled to identify evidence of floods. Historical runoff series were then used and specific hydrological studies were carried out in minor sub-basins.

Climate scenarios for 2098 were used in the calculation of the 100 year return floods in Sweden.

4.1.4 Determination of the most appropriate scale for mapping fluvial floods

Member States will determine the most appropriate scale of flood hazard maps and flood risk maps, and different scales can be chosen for instance depending on the location and type and purpose of the map.

For example, flood maps that are intended to raise public awareness should enable anyone to find out where there are risks of flooding in relation to their interests such as where they live. Maps for this purpose may have a relatively larger scale e.g. 1: 10,000 to 1: 25,000 compared to those used for national or regional planning purposes (1:100,000 to 1: 500,000). Also the mapping of some hazard features such as flow velocity may require a more detailed scale such as 1:1,000 or 1:5,000.

Table 4.4 summarises the main approaches and considerations reported to WISE by Member States.

Table 4.4 Main approaches and considerations for determination of the scale of maps

2	Member State
Maps zoom-able from national to street level	DK, ES, IE
To raise public awareness	LT, NL, PL, SK
For overview of flooding	RO
For spatial planning	PL, SK
Minimal accuracy specified in Regulations	SI
No information on this aspect reported to WISE	AT; BE; CY; CZ; DE; DK, EE; EL; ES; FI; FR; HR; HU; IE; IT; LV; PT; SE; UK
Not reported	BG
Fluvial floods not mapped	LU, MT

For most Member States (21) that mapped fluvial floods there was no information reported to WISE on how the most appropriate scale for the maps had been determined. Subsequent to the review of the first draft of this overview report, several Member States (e.g. PL and SK) provided relevant information which has been included in the above table.

Table 4.5 summarises the scales of the flood maps prepared by Member States. This has been derived from examples of national maps accessed by the links provided by Member States in the LinkToMS schema. The values in the table generally represent the maximum zoom-able extent of the maps where depicted elements (e.g. built up areas and roads) were still clearly distinguishable. More than one value for a Member States indicates that there are differences between map types and/or units of management within the Member State.

Table 4.5 Summary of the scales of flood maps prepared by Member States

Member State	Scale (1:n)		Member State	Scale (1:n)
AT	25,000; 50,000		IE	1,700
BE	2,500; 5,000; 18,500		IT	5,000; 10,000; 66,000; 72,000
BG	Not reported		LT	2,000
CY	5,000		LU	750
CZ	10,000		LV	10,000
DE	250; 1,000; 2,500; 5,000; 10,000; 15,000; 25,000; 150,000		MT	5,000; 10,000
DK	25 (Address level)		NL	1,000
EE	500		PL	10,000
EL	25,000		PT	2,000; 10,000
ES	1,000; 1,500; 2,000		RO	25,000
FI	1,000; 2,000; 10,000		SE	20,000
FR	24,000		SI	1,000
HR	25,000		SK	10,000; 50,000
HU	2,000,000		UK	10,000; 19,000

The minimal scale of the flood hazard maps is stipulated in Slovenia's national regulations as 1:5,000. Publicly accessible maps provided through a governmental official database in the interactive map viewer can be enlarged up to the scale 1:1,000. The flood hazard maps in Lithuania were prepared with the intention to raise public awareness and were prepared at a scale 1:2,000. In Romania the national map is said to be suitable as an overview representation but will not be detailed enough for projects on a local scale. Higher resolution maps are, therefore, available for almost all national river sectors and zooming-in to a more detailed scale is thus possible. Similarly maps in Denmark, Ireland and Spain are zoom-able from national level down to address level. In Cyprus, all maps produced (except for an overview map) have a scale of 1:5,000 but there was no explanation as to why this scale was chosen. There are regional differences in the scale of maps in the UK: in Scotland the largest scale the user can zoom to is 1:19,000 whereas in England and Wales and Northern Ireland, it is to 1:10,000.

A check of the maps on national web pages of 27 Member States indicated that 25 Member States had maps that had a scale of 1:25,000 or larger indicating that they should be appropriate for public use. Two Member States (Slovakia and Hungary) had maps that were of a smaller scale: in particular the maps for Hungary had a scale of 1 to 2,000,000 which seems to be inappropriate for public information and awareness purposes. The Slovakia Authorities subsequently stated that maps at a scale of 1:10,000 are being elaborated. There was no information reported for Bulgaria.

4.1.5 Resolution of models used in hazard maps for fluvial floods

Accurate digital maps and digital elevation models (DEM) are required to develop accurate representations of the extent and depth of flooding, particularly where floodplains are relatively flat. The horizontal and vertical accuracy of the maps will have a significant impact on the reliability and accuracy of the maps, particularly in determining potentially significant adverse consequences in any particular area. The EXCIMAP[4] handbook on good practices for flood mapping has suggested that minimum accuracy requirements are 10 m x 10 m (possibly 5 m x 5 m) for horizontal resolution and a minimum of 0.5 m for vertical.

Table 4.6 summarises the horizontal and vertical resolution of the maps and DEMs reported by Member States as being used in preparing their hazard maps for fluvial flooding.

Table 4.6 Summary of resolution of models used for the preparation of hazard maps from fluvial floods

	Metres	Member States
Vertical resolution/accuracy	15	LV
	1	BE (BXL; RW), EL
	0.8	IT (ITI012; ITI024; ITI029)
	0.5	CZ, RO
	0.4	IT (UoMs ITI012; ITI024)
	0.3	FI
	0.3 to 1	CZ
	0.25 to 0.6	SK
	0.2 to 0.3	SE
	0.2	ES, FR, IE
	0.18 to 0.3	CZ
	0.15	CY
	0.10 to 0.15	PL
	0.10	EE
	0.07 - 0.10	LT
	0.075	SI
No information reported		AT, DE, DK, HR, HU, NL, PT, UK

[4] EXCIMAP (2007) Handbook on good practices for flood mapping in Europe.

	Metres	Member States
Horizontal resolution (grid size)	0.3 x 0.3	FR
	0.5 x 0.5	FR, PT
	1 x 1	AT, DE, ES, FR, IT, LT, RO
	2 x 2	CY, ES, FI, IT, SE
	2.5 x 2.5	EE
	4 x 4	IT
	5 x 5	BE (VL), CZ, EE, EL, IE, FR, IT, UK (SC; EW)
	10 x 10	CZ, IE, IT, RO, UK (SC)
	20 x 20	LV, UK (SC)
	25 x 25	PT
	30 x 30	EL
	50 x 50	HU
	100 x 100	NL
No information reported		DK, HR, PL, SI, SK
Not reported		BG
Fluvial floods not mapped		LU, MT

It is clear that the resolution of the maps and models used varies between Member States and also between UoMs within Member States and in relation to the relative risk of flooding in the mapped areas. For example, in France maps with different resolutions were used: for general mapping a 1 x 1 m grid was used but with a 0.3 x 0.3 m resolution in the potentially flooded areas. In the UK the horizontal resolution in Scotland varied between 5 m and 20 m whilst in England and Wales a 5 m horizontal resolution was used.

Fourteen of the 17 Member States for which there was information on the vertical resolution of models used in flood mapping, and 16 of the 19 Member States with information on the horizontal resolution, met the good practice criteria proposed in the EXCIMAP handbook.

4.1.6 Taking existing flood defences into account

Article 6.4.d of the Flood Directive provides the possibility for Member States to map any type of information they consider useful. This may include existing flood defences and the level of protection they are expected to provide against the different flooding scenarios. The extent of flooding may be determined and shown without taking into account existing flood defences. The effects of the failure of defences on the extent of flooding may also be shown. Table 4.7 summarises the reported information on if, and how, flood defences have been taken into account by Member States in preparing flood hazard and flood risk maps.

Table 4.7 Summary of Member States where existing flood defences were taken into account

	Member States
Defences taken into account	AT, BE (BXL), DE, DK, EL, ES, FI, FR, HU, IE, NL, PL, SE, SK, RO, UK
Defences not taken into account	CY (1)
Defence failure not taken into account	LT, LV
No information	CZ, EE, IT, PT
Unclear	HR, SI
Not reported	BG
Fluvial floods not mapped	LU,(2) MT

(1) The CY Authorities subsequently indicated that "No major flood defences (i.e. dykes) exist on Cyprus rivers".

(2) The LU Authorities subsequently indicated that fluvial floods had been mapped though only pluvial had been reported to WISE

Sixteen Member States seem to have taken into account existing flood defences in preparing their flood maps. There was no relevant information for seven Member States. In some cases flood defences may be mentioned but there is no explicit information as to whether or not these have been taken into account in the mapping of floods: these cases are indicated as unclear in the above table for two Member States.

Existing flood defences were taken into account in Austria for the low probability scenario by considering the effects of flood defences protecting against a medium probability event (return period 100 years). Furthermore, the risk of flood defences failing or being disturbed against a 300 year flood was also taken into account. In Denmark the overtopping of dikes was taken into account but dike failure was not considered. The maps prepared in Finland show areas where one or more of the flood scenarios exceed the flood protection level. In Hungary levee breaches were taken into account in the calculation of the probability scenarios. In Lithuania the existing flood defences (dikes) were considered as relief features but the potential for failure of the existing flood defences was not considered in the flood mapping.

4.1.7 Taking existing infrastructure or buildings into account

Existing infrastructure and buildings will potentially affect flood extents, conveyance routes, and flood water velocities. Table 4.8 summarises the reported information on whether such infrastructure and buildings have been taken into account in the preparation of hazard maps for fluvial flooding.

Table 4.8 Summary of Member States where existing infrastructure or buildings were taken into account in the mapping of fluvial floods

	Member States
Taken into account	CY, CZ, DE, DK, EE, EL, ES, FI, HR, HU, IE, LT, LV, NL, PL, RO, SE, SI, SK, UK
No information	AT, BE, FR, IT, PT
Not reported	BG
Fluvial floods not mapped	LU, MT

Information was reported for 20 Member States. In Cyprus all hydraulic structures such as bridges and culverts that affect water flow in the modelled water bodies were registered and considered: overall 340 such structures were characterised and integrated into the modelling. Existing infrastructure was incorporated into the existing digital terrain models in Germany, but no details were reported. For Denmark infrastructure and buildings can be shown as separate background layers on the on-line maps. The background map in Estonia shows the individual buildings and in combination with the flood hazard and risk map, the areas at risk for flooding can be assessed. In Croatia a map has been developed showing existing infrastructures: bridges, dikes, roads and railroads and storage areas are incorporated in the hydraulic models. Existing infrastructure (roads, railroads, etc.) was considered as relief features in the maps produced by Lithuania. In the UK (Northern Ireland) buildings were emphasised to give accurate flow paths with some flow being allowed to penetrate buildings for modelling purposes.

4.1.8 Identified uncertainties in the methods and resultant maps and assessments

Eighteen Member States described some uncertainties in the method used to prepare their maps: this doesn't necessarily mean that there are no uncertainties in the methods applied by the other 9 Member States.

In the Czech Republic there were reported uncertainties in the geodetic background information, in the determination of return periods and in the development of hydrodynamic models. In Denmark large uncertainty in determining the extreme scenario was mentioned. Three sources of uncertainty were described by Spain: the effects of erosion and other geomorphological processes are only taken into consideration in specific locations and by specific criteria; the mathematical models might not adequately reflect the effect of certain mobile elements (fallen trees, cars) that can hinder and deviate flood flows; and, in large urban areas with multiple elements there might be computational limitations. In Croatia it is stated that a better Digital Elevation Model (DEM) and an improvement in the number and quality of river cross sections for the models would improve the maps. The statistical values of different return period floods were reported to have uncertainties in Hungary because of the extreme floods of recent years. Ireland also indicated that there were some errors in the DEM for some localities. In Sweden, the uncertainty in altitude was less than 0.1 m for flat hard terrain, but considerably larger for steeper terrain and for weakly defined ground levels. The uncertainty is also higher in forested areas, so small topographic variations may not be seen on the map. In the UK (Scotland), uncertainties were related to the data used to create the maps such as hydrological and topographical information and modelling techniques.

4.2 Pluvial floods

4.2.1 Expression of probabilities for flood scenarios

Six Member States have produced specific hazard maps for pluvial floods: Luxembourg and Malta only mapped this source of flooding.[5] Eight other Member States produced maps combining the hazard and risk of pluvial flooding with other sources of flooding. Two other Member States (Germany and Hungary) had reported in 2012 that pluvial floods were associated with APSFR but these do not seem to have been mapped: the reasons for this are not known for Germany but are explained for Hungary in Section 3 of this report. Table 4.9 summarises the probabilities used by Member States (note that there may be differences between UoMs within the Member State for each of the scenarios mapped for pluvial flooding). This information is also summarised at the EU level in Figure 4.3.

Table 4.9 Summary of scenarios mapped for pluvial flooding with associated expressions of probabilities

MS	Low probability		Medium probability		High probability	
	Return Period (years)	Percentage probability	Return Period (years)	Percentage probability	Return Period (years)	Percentage probability
AT	300		100		30	
BE	100; 1000		25-50; 100		10	
BG	Not reported					
CY	Source not specifically mapped					
CZ	Source not specifically mapped					
DE	Source not specifically mapped					
DK	Source not specifically mapped					
EE	Combined with fluvial flooding					
EL	Source not specifically mapped					
ES	Combined with fluvial flooding					
FI	Source not specifically mapped					
FR	Combined with fluvial flooding					
HR	Source not specifically mapped					
HU	Source not specifically mapped					
IE	Source not specifically mapped					
IT	500		100; 200		30; 50	

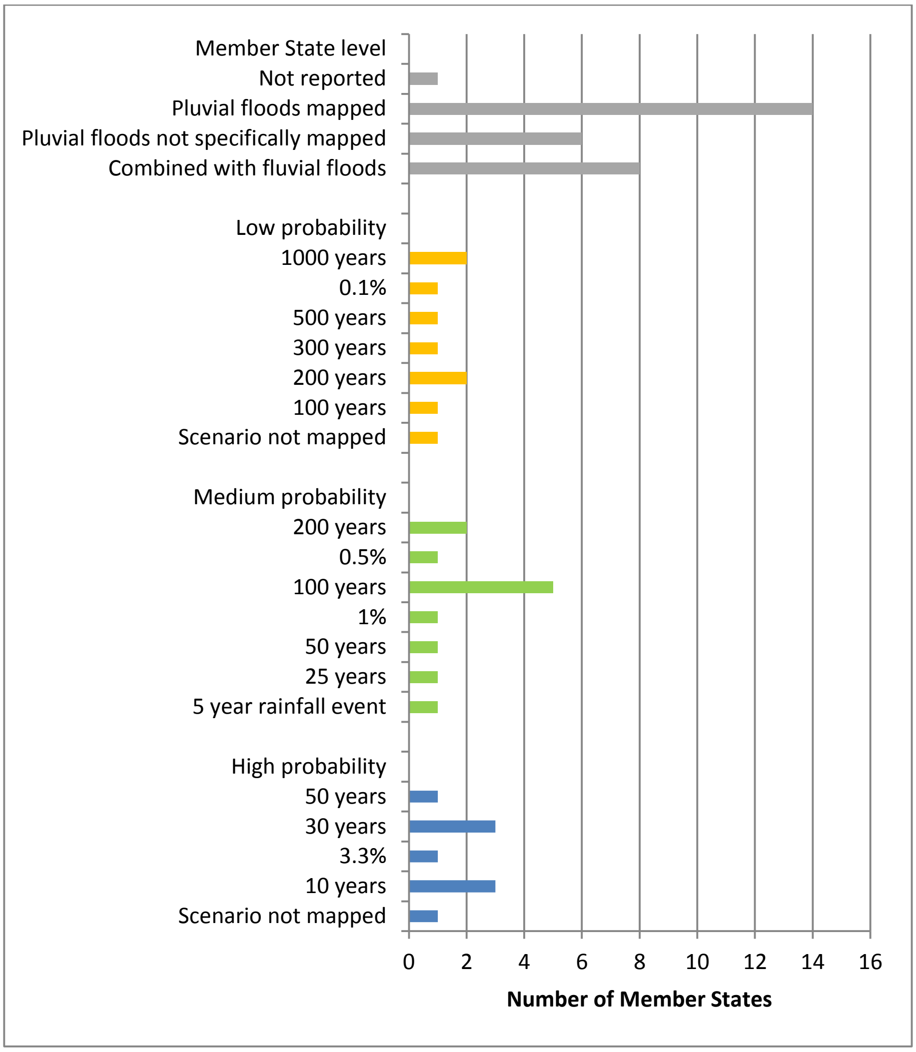
[5] The LU Authorities subsequently indicated that fluvial floods had been mapped though only pluvial had been reported to WISE

MS	Low probability		Medium probability		High probability	
	Return Period (years)	Percentage probability	Return Period (years)	Percentage probability	Return Period (years)	Percentage probability
LT	Combined with fluvial flooding					
LU	200		100		10	
LV	Source not specifically mapped					
MT (1)			5			
NL	Combined with fluvial flooding and (where relevant) floods from artificial water bearing infrastructure					
PL	Source not specifically mapped					
PT	Source not specifically mapped					
RO	Combined with fluvial flooding					
SE	Source not specifically mapped					
SI	Combined with fluvial flooding					
SK (2)	Combined with fluvial flooding					
UK	200; 1000	0.10%	100; 200	1%; 0.5%	10 ; 30	3.30%

1 Malta maps based on a medium probability (1 in 5) rainfall event

2 Generally combined with fluvial flooding though SK provided specific details of pluvial flooding for one APSFR for visualisation on a Europe scale flood map.

Figure 4.3 Number of Member States applying different expressions of probabilities for the three probability scenarios for pluvial flooding



Note that more than one expression of probability may apply to each scenario in each Member State

Twelve of the 13 Member States mapping pluvial floods used a return period of 100 years or an annual probability of 1% for the medium probability scenario: the exception was Malta. Given the water conveyance function and extremely short temporal scale of flood events in Malta, no information on the hydrological characteristics of past flood events has ever been recorded. Therefore the modelling of flood hazard areas was based on the probabilities associated with rainfall events. This was based on a 110 mm rainfall event in 24 hours, which equates to a 1 in 5 rainfall event. It was concluded that the flood hazard maps indicate the areas which could potentially experience flooding arising from medium probability rainfall events.

For the low probability scenarios there was a range of probabilities used from a 100 year return period in one Member State (Belgium-BXL) to 1,000 year return period in three Member States (Belgium (RW), Estonia and the UK). Similarly, high probability scenarios were expressed from 10 year (five Member States) to 50 year return periods (two Member States).

4.2.2 Hazard elements

Table 4.10 summarises by Member State, and Figure 4.4 provides an EU overview of, the hazard elements for each of the mapped flooding scenarios. The summaries in the table and figure are based on the reported methodological information and also from a qualitative check of a sub-sample of the Member States' maps. The information is for the six Member States where there are separate maps prepared for pluvial floods.

Table 4.10 Elements included in the hazard maps of pluvial flooding

MS	Flood extent			Water depth/level			Water Flow Velocities		
Scenario	Low	Medium	High	Low	Medium	High	Low	Medium	High
AT	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
BE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
BG(NR)									
CY(NM)									
CZ(NM)									
DE(NM)									
DK(NM)									
EE(NM)									
EL(NM)									
ES(NM)									
FI(NM)									
FR(NM)									
HR(NM)									
HU(NM)									
IE(NM)									
IT	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
LT(NM)									
LU	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
LV(NM)									
MT	No	Yes	No	No	Yes	No	No	No	No
NL(NM)									
PL(NM)									
PT(NM)									
RO(NM)									
SE(NM)									
SI(NM)									
SK(NM)									
UK	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

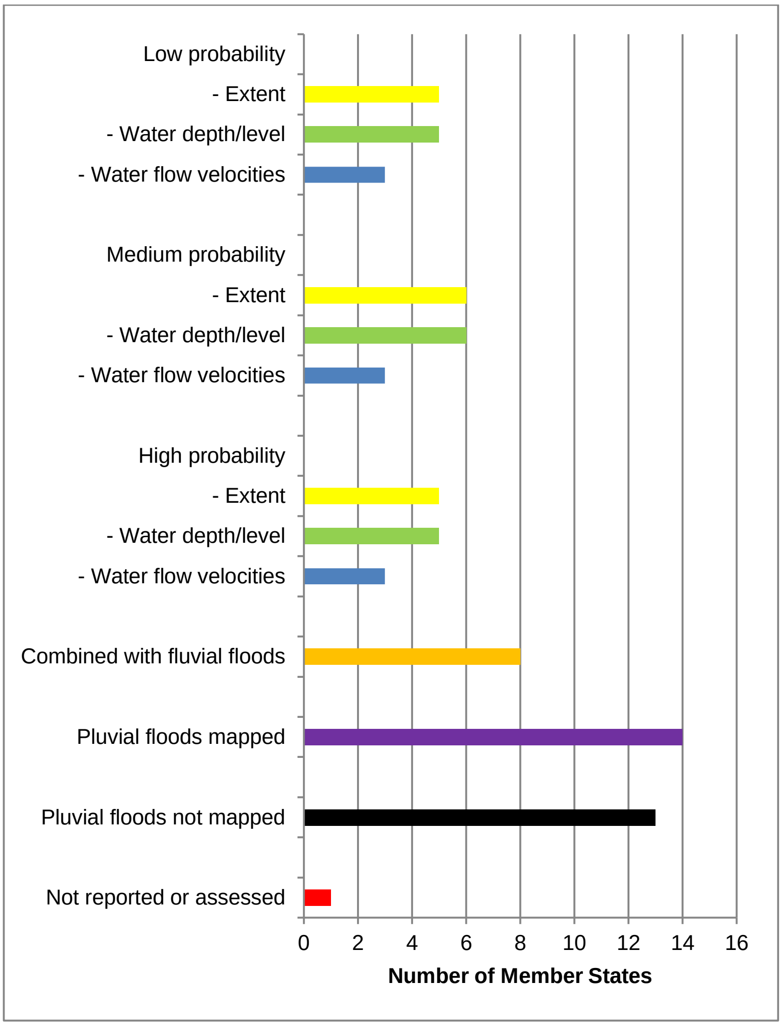
Notes

NR: Bulgaria not yet reported on its flood hazard and flood risk maps.

NM: Specific pluvial flood maps not produced though fluvial floods might be combined with other relevant sources of floods.

NL: The NL Authorities subsequently indicated that there is a "voluntary" map which shows the sources of flooding; which would be published in the near future.

Figure 4.4 Number of Member States including the different elements in their hazard maps for pluvial flooding



Five of the six Member States whose specific pluvial flood maps were assessed provided the required hazard elements (flood extent and water depth/level) for the required probability scenarios (low and medium). The same five Member States also had high probability scenario maps showing these two hazard elements. Three Member States also showed water flow velocities on all three probability scenario maps. Malta only produced a pluvial flooding map based on a 1 in 5 year rainfall event which they considered to be equivalent to a medium probability event.

For the assessment of pluvial floods in Finland, all the municipalities were consulted and were asked to pull together the existing data for rainfall/snowmelt water. This exercise allowed municipalities to raise their capacity in terms of having an overview of the weaknesses and existing gaps in terms of preparedness for floods. However, no pluvial flood maps have yet been prepared.

The Luxembourg pluvial flood maps that are accessible on the web are dynamic, i.e. initial access is a national map at a scale of 1:450,000, which can be zoomed in to a scale of 1:750 (showing individual buildings).[6] To eliminate uncertainties in the available statistical data, a comparison was made with neighbouring countries before being validated.

In the UK (England and Wales) the results from the computer model used to assess pluvial flooding were validated using historical observations and local modelling data in three pilot areas. Modelling outputs in Northern Ireland were validated with an urban flood event from 2007. The medium probability scenario (200 year return period) for pluvial sources in Scotland included an assessment of the effects of climate change and is used as a proxy for the (current) 1000-year return period and provides for the low probability event.

4.3 Sea Water

4.3.1 Probabilities associated with mapped scenarios

Eleven of the 23 Member States with coastlines have produced specific sea water flood maps. Seven Member States have combined the mapping of sea water floods with other relevant sources including Belgium and the Netherlands who prepared combined fluvial and sea water flood maps. The UK (England and Wales) produced maps with the source being the main rivers and coastal flooding; other regions of the UK prepared specific coastal flooding maps. The exceptions where sea water flooding maps have not been prepared in Member States with a coastline are Cyprus, Malta, Portugal, Romania and Sweden. In addition, Bulgaria has not reported yet on its flood maps.

Romania reported APSFR associated with sea water flooding in 2012 but sea water flood maps have not been prepared. The Romanian Authorities have explained that at the present time there is neither the research base nor mathematical models to undertake the mapping of flood hazard and flood risk from seawater (coastal flooding). They have also stated that the main source of floods in Romania is fluvial and that no floods have been recorded as being caused exclusively by marine sources.

Table 4.11 summarises the probabilities used by Member States for each of the scenarios mapped for sea water flooding. Figure 4.5 provides an EU overview of the information.

All 17 Member States that mapped sea water floods (either specifically or in combination with other sources) produced medium probability scenario maps. Fifteen Member States used a 100 year return period or a 1% annual probability for the medium probability flooding scenario; Ireland used a probability of 0.5%. Fifteen Member States also produced low probability sea water flooding maps. The exception was Greece (GR12 only), where a low probability flooding scenario had not been identified from the available information. High probability scenarios were not mapped in Belgium, Spain and Poland.

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[6] The LU Authorities subsequently indicated that fluvial floods had been mapped though only pluvial had been reported to WISE.

Table 4.11 Summary of scenarios mapped for sea water flooding with associated expressions of probabilities

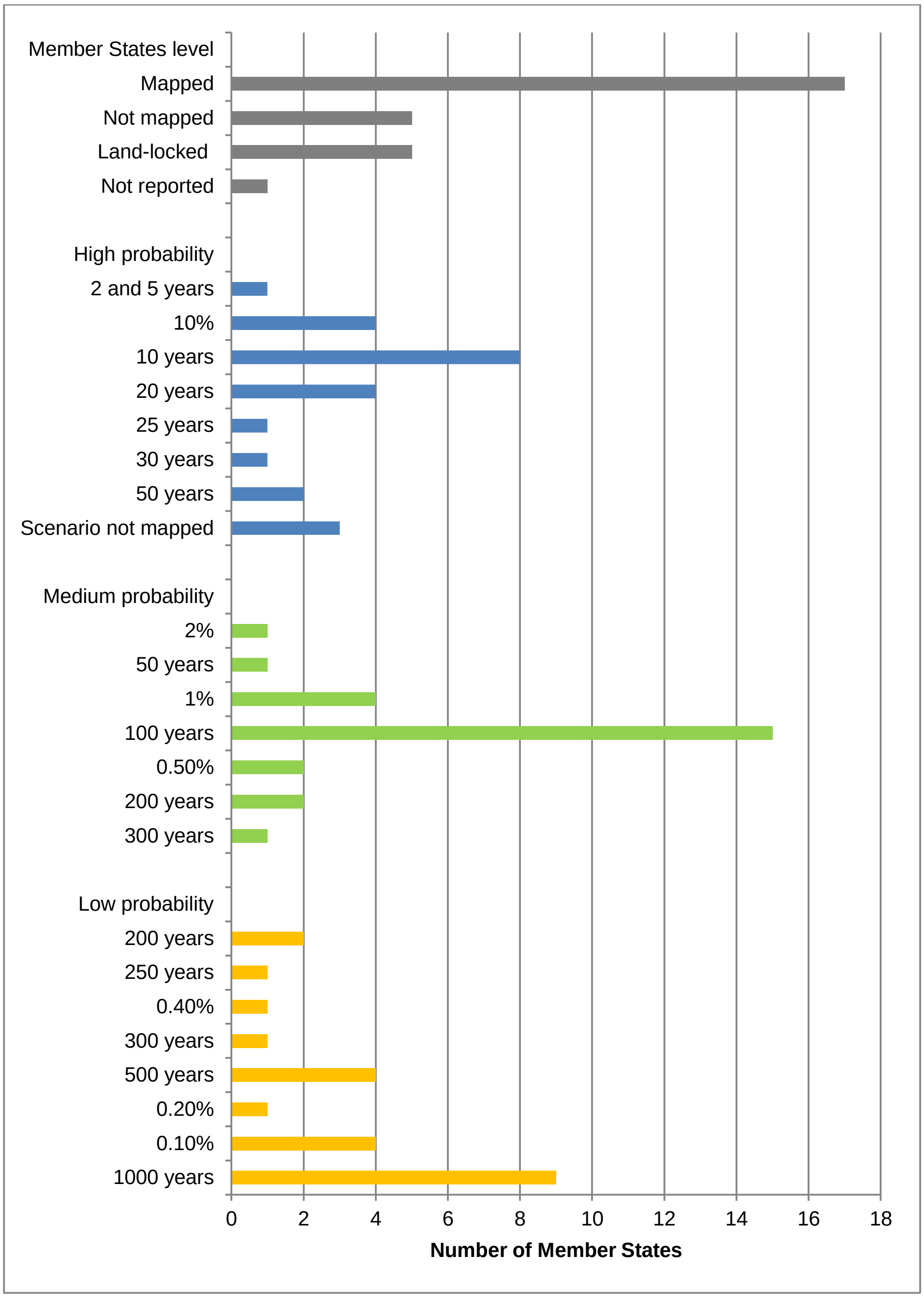
MS	Low probability		Medium probability		High probability	
	Return Period (Years)	Percentage probability	Return Period (Years)	Percentage probability	Return Period (Years)	Percentage probability
AT	Land-locked					
BE[(2)]	1000		100		Not mapped	
BG	Not reported					
CY	Not mapped					
CZ	Land-locked					
DE	200		100; 200		20	
DK	1000		100		20	
EE	1000		100		10; 50	
EL[(1)]	Not mapped		100		50	
ES	500		100		Not mapped	
FI	250; 1000	0.1%; 0.4%	50; 100	1%;2%	20; 10; 5; 2	5%; 10%; 20%; 50%
FR	1000		100; 300		10; 30	
HR	1000		100		25	
HU	Land-locked					
IE		0.1%		0.50%		10%
IT	300: 500		100		20; 500	
LT	1000	0.10%	100	1%	10	10%
LU	Land-locked					
LV	200		100		10	
MT	Not mapped					
NL[(2)]	1000		100		10	
PL	500	0.20%	100	1%	Not mapped	
PT	Not mapped					
RO	Not mapped					
SE	Not mapped					
SI	500		100		10	
SK	Land-locked					
UK	1000	0.10%	200	0.5%; 1%	10	10%

Note:

(1) information from EL is for only one UoM (GR12)

(2) mapped in combination with fluvial flooding.

Figure 4.5 Number of Member States applying different expressions of probabilities for the three different probability scenarios for sea water flooding



Note: Member States or regions within a Member State that just reported probabilities as percentages were included in the totals for the percentage expressions in the figure above. More than one probability was reported for each scenario by some Member States.

Only the 100 and 1000 year return periods have been integrated in the Floods Directive maps for Belgium (Flanders) though floods with 4,000 and 17,000 year return periods are also considered in the Integrated Coast Security Plan for Belgium.

The reported methodology for Denmark describes 20, 100 and 1000 year return period scenarios, but in the online maps the probability scenarios are not accessible. Instead the sea water level can be increased from 10 to 700 cm in 10 cm steps and changes in flooded area and water depth are shown.

The probability level for all maps in Finland is displayed either as a percentage, in text form (ranging from very rare flooding up to frequent/yearly flooding) or occurrence rate (probability is shown for 1/1000, 1/250, 1/100, 1/50, 1/20, 1/10, 1/5 and 1/2 year).

Different UoMs/areas in Italy seem to have used different expressions of probability. In one UoM (ITN011) a 100 year return period is considered as low probability, but to conform with the Floods Directive reporting schemas (as stated by the IT Authorities), the scenario has been reported as medium probability. The Italian Authorities subsequently explained that three probability scenarios (20, 50 and 100 years) had been calculated in ITN011 and the 100 year return period was simply the highest one. Higher return periods had not been considered significant in relation to the topographical and meteorological local conditions in this UoM. In another region (ITR091) the areas at risk from coastal flooding are those with events of 50 year return periods. In ITI012 medium probability is expressed as events with a 100 year return period for coastal floods.

Flood hazard maps for coastal areas in Poland have been limited to low and medium probability flooding scenarios. The high probability scenario was not mapped because the flood defences were considered to be adequate to protect coastal areas for this scenario. The entire length of the sea coast (including the seaports and harbours) is considered to be fully protected against 5 % probability coastal floods.

The flood maps for coastal waters in Slovenia show four classes of hazard. The very low risk class is for when flooding could be caused by exceptional natural or man-made causes (heavy rain, malfunction or destruction of flood defence and other water structures, etc.).

4.3.2 Elements included in the hazard maps of sea water flooding

Table 4.12 summarises by Member State, and Figure 4.6 provides an EU overview of, the hazard elements for each of the mapped scenarios for sea water flooding (either specifically or in combination with other sources). The summaries in the table and figure are based on the reported methodological information and also from a qualitative check of a sub-sample of the Member States' maps.

Table 4.12 Elements included in the hazard maps of sea water flooding

MS	Flood extent				Water depth/level				Water Flow Velocities		
	Low	Medium	High		Low	Medium	High		Low	Medium	High
AT						Land-locked					
BE	Yes	Yes	No		Yes	Yes	No		Yes	Yes	No
BG(NR)											
CY(NM)											
CZ						Land-locked					
DE	Yes	Yes	Yes		Yes	Yes	Yes		No	No	No
DK	No	No	No		No	No	No		No	No	No
EE	Yes	Yes	Yes		Yes	Yes	Yes		No	No	No
EL	No	Yes	Yes		No	Yes	Yes		No	No	No
ES	Yes	Yes	No		Yes	Yes	No		No	No	No
FI	Yes	Yes	Yes		Yes	Yes	Yes		No	No	No
FR	Yes	Yes	Yes		Yes	Yes	Yes		No	No	No
HR	Yes	Yes	Yes		Yes	Yes	Yes		No	No	No
HU						Land-locked					
IE	Yes	Yes	Yes		Yes	Yes	Yes		Yes	Yes	Yes
IT	Yes	Yes	Yes		Yes	Yes	Yes		Yes	Yes	Yes
LT	Yes	Yes	Yes		Yes	Yes	Yes		No	No	No
LU						Land-locked					
LV	Yes	Yes	Yes		No	No	No		No	No	No
MT(NM)											
NL	Yes	Yes	Yes		Yes	Yes	Yes		Yes	No	No
PL	Yes	Yes	No		Yes	Yes	No		No	No	No
PT(NM)											
RO(NM)											
SE(NM)											
SI	Yes	Yes	Yes		No	No	No		No	No	No
SK						Land-locked					
UK	Yes	Yes	Yes		Yes	Yes	Yes		Yes	Yes	Yes

Note:

NR: Bulgaria not yet reported on flood hazard and flood risk maps

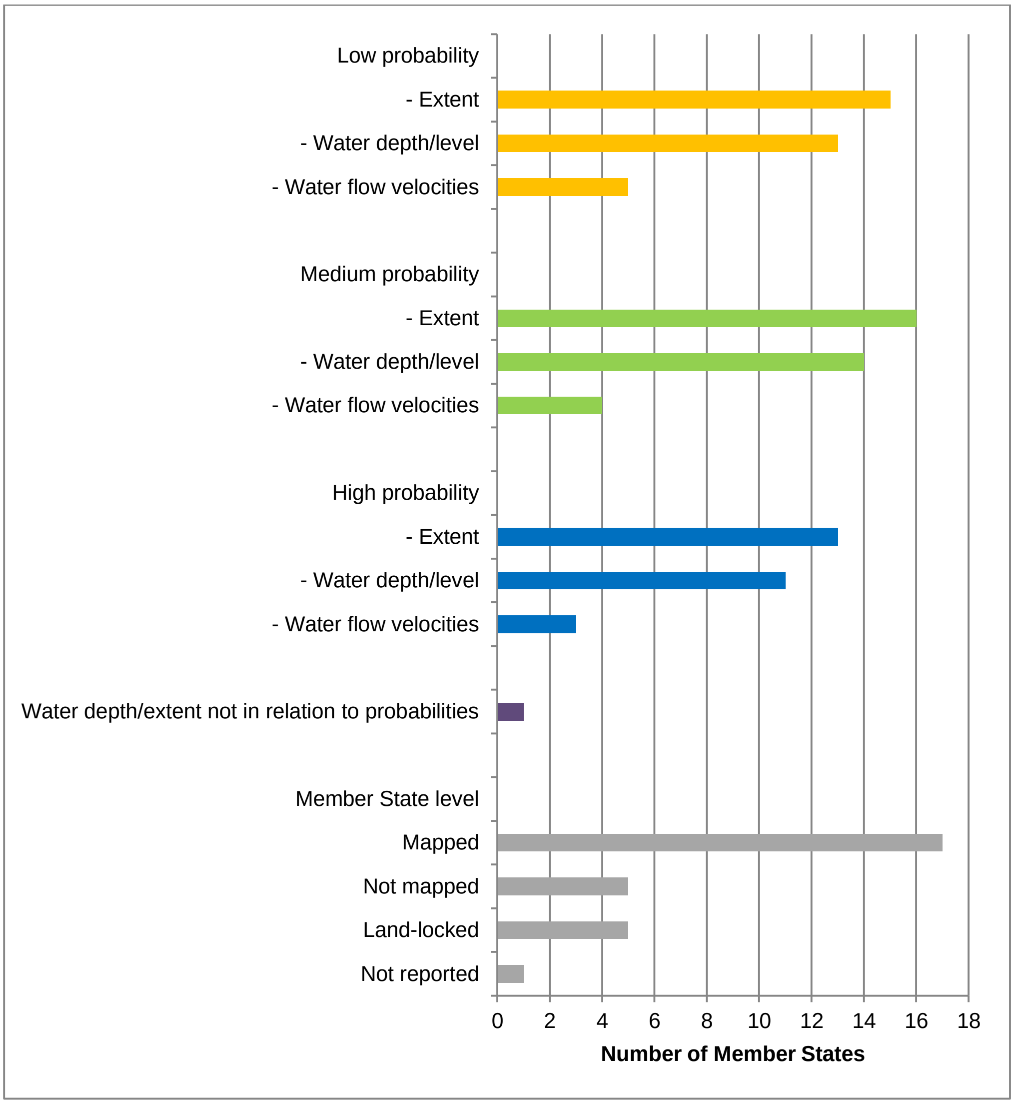
NM: Seawater floods not mapped

DK: Water depth and extent shown but not in relation to probabilities

BE, EE, HR, IE, LV, NL, UK (UK (SC & NI) also prepared specific source maps): mapped in combination with fluvial flooding.

There was information on the hazard elements included in the maps prepared by the 17 Member States that have mapped sea water floods. For one of these (Denmark), water depth and extent are shown but not in relation to probabilities. The remaining 16 included the required hazard element of flood extent but only 14 included the other required element of water depth/level for the medium probability scenario: Slovenia combined water depth and water velocity in its maps. Member States are also required to prepare low probability maps as well as medium probability (unless they have applied Article 6.6 when only low probability is required). Greece (based on one UoM only) did not prepare low probability maps (because of the lack of available information) whereas the other 15 Member States did, and they included flood extent. Only five Member States (BE, IE, IT, NL, UK) included water flow velocities on their hazard maps.

Figure 4.6 Number of Member States including the different elements in their hazard maps for sea water flooding



4.3.3 Calculation of return periods and probabilities for seawater floods

For Denmark the water levels equivalent to the high and medium probability floods were based on statistical analysis of observation data. The water levels equating to the low probability (1000 year return period) were either derived by statistical data or based on the storm flood of 1872. In addition, future climate change scenarios were considered for the high and medium probability scenarios. The predicted high probability (20 year return period) flood for 2050 factored in a 30 cm sea level rise and was also corrected for land movement; the medium probability (100 year return period) flood was predicted for 2100 assuming an 80 cm sea level rise, corrected for land movement. The 2100 scenario was chosen as this represents the typical lifetime of around 100 years of large infrastructure investments such as flood defences.

In Poland, the maximum water levels with a specified exceedance probability for the coast and estuary sections of rivers under the influence of seawater were calculated in order to use the results for hydrodynamic modelling. The calculation was based on statistical analysis of historical hydrological data covering at least 30 years. The impact of climate change was also taken into consideration for sea-water floods. An increase in sea level along the Polish Baltic coast caused by climate change was included in the formula for calculating water level with a specified exceedance probability. For flood hazard maps, the increase for the years 2011-2030 amounting to 5 cm was taken into account.

Climate change was also factored into flooding scenarios in the UK (Scotland) where eight probabilities were tested (10, 25, 50, 100, 200, 200 plus climate change, 1,000 and 10,000 year return periods). Climate change was said to be considered in Germany for the coastal flooding scenarios.

In contrast, the predicted effects of climate change were not considered for the high and low probability scenarios in France because the current knowledge of the effect of climate change on other types of hazards were not considered sufficient to be taken into account.

In general flooding probabilities and return periods can be calculated from a statistical analysis of observed hydro-meteorological and tidal level data, perhaps using an appropriate hydrodynamic model. When observational data are not suitable (e.g. not a long enough time series) modelling may be solely used.

For example in Estonia, the probability scenarios were calculated using the existing hydro-meteorological measurement and observation series except for locations where no such data was available and modelling was used. A similar approach was taken in Germany where return periods were calculated from long term measurements, though the length of the period was not reported. For the medium probabilities a national approach was used and for low and high probabilities the approach was mainly based on modelling exercises. In Finland, the return periods were statistically calculated using tidal records or the data from water level measuring stations. The calculations take into account short-term water level fluctuations, the theoretical mean of water, and changes in land elevation due to ocean height variations. The probabilities of flooding in Lithuania were calculated from the time series (1960-2010) of the water level measurement stations located in the Baltic Sea and the Curonian Lagoon.

In the UK (Northern Ireland) the medium probability scenario was selected to be consistent with the return periods used in current land use planning policy: high and low probabilities were selected after consultation with the Competent Authority in Ireland as these needed to be consistent across the international RBDs.

4.3.4 Determination of the most appropriate scale for mapping sea water floods

There is no common approach in the scales used for the coastal flooding maps in Germany; scales also vary within a UoM. The scales of the more detailed maps range from 1:2,500 to 1:25,000 whereas for overview maps they range from 1:25,000 to 1:1,500,000. There is no explanation of how the scale of the maps was determined.

In Denmark the maps are zoom-able from national level down to the individual address levels. The smallest scale of Spain's maps starts usually at the National or RBD/regional level, and zooming to about 1:1,000 or 1:1,500 is possible. The flood hazard maps for Lithuania were prepared with the intention to raise public awareness and use the scale 1:2,000. The minimal accuracy of Slovenia's flood hazard maps is decreed at 1:5,000: some publicly accessible maps can be enlarged up to the scale 1:1,000. The flood maps are at a scale of 1:10,000 in Poland and are said to be appropriate for raising public awareness, spatial planning, response and crisis management and for insurance purposes.

The scale of flood maps at their maximum zoom-able inward extent (largest scale where features are clearly discernible on the map) has been summarised in Table 4.5. The table is for flood maps in general and makes no differentiation between flood sources mapped.

4.3.5 Resolution of models used in hazard maps for sea water flooding

Table 4.12 summarises the horizontal and vertical resolution of the maps and DEMs reported by Member States as being used in preparing their hazard maps for sea water flooding. The EXCIMAP[7] handbook on good practices for flood mapping has suggested that minimum requirements are 10 m x 10 m (possibly 5 m x 5 m) for horizontal resolution and a minimum of 0.5 m for vertical. Table 4.13 shows that all the models applied for coastal flooding by Member States for which information was reported met these best practice criteria except for the vertical resolution of the DEM used by Greece and Spain.

[7] EXCIMAP (2007) Handbook on good practices for flood mapping in Europe.

Table 4.13 Summary of resolution of models used for the preparation of hazard maps for sea water floods

	Metres	Member States
Vertical resolution/accuracy	1-2	ES
	1.0	EL
	0.4	IT
	0.3	FI
	0.2	IE
	0.10 to 0.15	PL
	0.10	EE
	0.075	SI.
	0.07 to 0.10	LT
Horizontal resolution (grid size)	1 x 1	LT
	2 x 2	FI
	2.5 x 2.5 to 5 x 5	EE
	5 x 5	BE (VL), EL, ES, IT, UK (SC)
	5 x 5 to 10 x 10	IE

A horizontal resolution of 5 x 5 m was used for all the UoMs in Spain that reported on coastal floods: the vertical resolution of the DTM for coastal waters is lower (1 to 2 m) than for fluvial floods (0.20 m) because they have not been developed from LiDAR technology. For Finland a 2 x 2 m horizontal resolution was used with a 0.3 m vertical resolution on average. The Digital Terrain Model (DTM) in Ireland has a typical grid scale of 5 or 10 m and vertical resolution of typically less than 0.2 m. In Italy the DTM used in the only UoM (ITI012) that provided specific relevant information for coastal floods has a 5 x 5 m horizontal resolution, with a vertical precision of 0.4 m. The DTMs used to calculate flood hazards in Lithuania have a horizontal resolution of 1 x 1 m.

4.3.6 Taking existing flood defences into account

Existing coastal flood defences have been taken into account in the flood maps in Germany but it is unclear how. Spain also indicated that the DTMs used in the preparation of flood maps took into account all existing flood defences. Overtopping of coastal defence infrastructure was considered in Denmark, but not technical failure: different types of coastal defence infrastructure can be displayed in a separate map layer. A general picture of the benefit of flood protection can be viewed on the maps in Finland. Where one or more of the flood scenarios exceeds the flood protection level in an area, embankment failure/overrun is indicated on the maps.

In the Netherlands the low probability scenario has only been modelled for coastal floods where there are regular flood defences in place. This is because of the high safety standards for the primary coastal flood defences (protection against 1/4,000 and 1/10,000 year events). All three probability scenarios were modelled for the unprotected areas along the coast.

4.4 Groundwater

Only two Member States have produced flood maps for groundwater (Belgium (Brussels) and Hungary) and two others (Denmark and UK (Scotland) have assessed the risk of groundwater flooding but not produced specific maps.

Four other Member States (ES, IE, RO and SK) reported APSFRs associated with groundwater floods in 2012 that seemed not to have been subsequently mapped. In Spain there is one APSFR (in UoM ES010) associated with groundwater flooding and it was combined/mapped with fluvial flooding. Additional information was subsequently provided by the Slovakia Authorities indicating that the mapping of fluvial floods included areas where flooding is also caused by other sources (such as groundwater) to ensure the clarity of the maps. The IE Authorities stated that maps of groundwater flooding were being prepared and will be provided at a later date. The Romania Authorities subsequently stated that they have not designated any APSFR having groundwater as the main flooding source: presumably the flood hazard and risk from groundwater has been combined with fluvial flood maps.

Table 4.14 summarises the probabilities used by Member States for each of the scenarios mapped for groundwater flooding.

Table 4.14 Summary of scenarios mapped for groundwater flooding with associated expressions of probabilities

MS	Low probability		Medium probability		High probability	
	Return Period (years)	Percentage probability	Return Period (years)	Percentage probability	Return Period (years)	Percentage probability
AT	Not mapped					
BE[1]	100		25 to 50		10	
BG	Not reported					
CY	Not mapped					
CZ	Not mapped					
DE	Not mapped					
DK	Assessed but not in detailed maps					
EE	Not mapped					
EL	Not mapped					
ES	Combined with fluvial floods in one APSFR					
FI	Not mapped					
FR	Not mapped					
HR[2]	Not mapped					
HU	1000	1 ‰				
IE	Not mapped					
IT	Not mapped					
LT	Not mapped					

MS	Low probability		Medium probability		High probability	
	Return Period (years)	Percentage probability	Return Period (years)	Percentage probability	Return Period (years)	Percentage probability
LU	Not mapped					
LV	Not mapped					
MT	Not mapped					
NL	Not mapped					
PL	Not mapped					
PT	Not mapped					
RO	Not mapped					
SE	Not mapped					
SI	Not mapped					
SK(3)	Not mapped					
UK(4)	Proxy for low probability map without a calculated return period					

Notes
1. Brussels region
2. In Croatia certain groundwater (Karst phenomena) flooding has been included in fluvial maps as sometimes it is not possible to distinguish between the sources
3 Where relevant, groundwater flooding has been combined with the mapping of fluvial floods
4. Scotland

Groundwater floods were reported to WISE (in the FHRM schema) by the Brussels region of Belgium but there was no reported information on how these maps had been produced.

In Denmark groundwater floods are not mapped in detail. The web-GIS of flood maps shows different layers relevant for groundwater flooding: groundwater level 1991-2010, changes in groundwater level 2021-50 in a dry climate model, median climate model and wet climate model. The resolution is very coarse (approximately 500 m) and not adequate for identifying the risk to single properties. There was no information reported on the groundwater flood assessment methodology.

Hungary has prepared only a low probability (1,000 year return period) groundwater (excess surface water flooding) flood map and on the map only flood extent information is available: no water depth or flow velocity were given on the map. Hungary used a 1: 2,000,000 scale for all published flood hazard and flood risk maps. No clear information was provided on why this scale was used.

In the UK (Scotland) the groundwater map is not a flood hazard map, it is considered to be a proxy for a low probability flood map: it is a high-level generalised assessment. There is a lack of appropriate monitoring data so a return period has not been attributed. The map can be used to identify catchments where there is a significant predicted contribution to flood risk or where there are historic records of flooding.

4.5 Artificial water bearing infrastructure

Six Member States (BE (Brussels), FI, IT, LT, SE and UK (England, Wales and Northern Ireland)) have produced specific maps of floods arising from artificial water bearing infrastructure. Three others (HR, NL and SI) have combined the hazard and risk from this source with other relevant sources of floods). In the Netherlands all relevant flood sources have been mapped (without differentiation between specific sources) on the same map which includes, where relevant, floods from artificial bearing infrastructure such as canals. In Croatia and Slovenia this source of flood had been combined with the maps on fluvial flooding.

The Finnish Authorities subsequently indicated that flood hazard maps for dam breach have been prepared for the relevant Finnish APSFR in connection to specific Finnish legislation on dam safety. A separate layer on the flood hazard area from a dam breach is available in the Finnish version of the national flood map service.

In addition, two Member States (HU and RO) have reported APSFRs that were associated with flooding from artificial water bearing infrastructure but seemingly have not mapped this source.

The Hungary Authorities subsequently stated that the failure of artificial water-bearing infrastructure (reservoirs gates and other structures) because of their size does not generate water related damage in the considered probability scenarios and was therefore not investigated further in the mapping work.

The Romania Authorities indicated that two APSFR have a flood mechanism of “Defence or infrastructural failure”; these 2 APSFRs have been symbolised in a specific way on the (fluvial) maps.

Table 4.15 summarises the approaches used by Member States in mapping floods from artificial water bearing infrastructure.

Table 4.15 Approaches used in mapping floods from artificial water bearing infrastructure

MS	Source mapped	Flood Extent	Water Depth/ Level	Water Flow Velocities	Summary
AT	No				
BE	Yes	Yes	No	No	Three flooding scenarios are reported for this source for the Brussels region.
BG	Not reported				
CY	No				
CZ	No				
DE	No				

MS	Source mapped	Flood Extent	Water Depth/ Level	Water Flow Velocities	Summary
DK	No				
EE	No				
EL	No				
ES	No				
FI	Yes	ni	ni	ni	One APSFR was reported to be associated with this flood source in 2012.
FR	No				
HR	No				Flooding due to possible collapse of embankments on the larger watercourses and the destruction of large dams: equivalent to a low probability scenario. Combined with fluvial flood map.
HU	No				One APSFR was reported to be associated with this flood source in 2012.
IE	No				
IT	Yes	ni	ni	ni	One UoM (ITi02), medium probability of 200 year return period.
LT	Yes	No	Yes	No	Maps produced for failure of 5 dams but the maps are not accessible by the general public.
LU	No				
LV	No				Three APSFR were reported to be associated with this flood source but the LV Authorities confirmed that hazard of floods arising from artificial water bearing infrastructure have not been mapped: no reasons were given.
MT	No				
NL	No				All relevant sources of floods are combined on one map in the Netherlands including, where relevant, floods from artificial water bearing infrastructure.
PL	No				
PT	No				
RO	No				87 APSFRs were reported to be associated with this flood source in 2012. There is no clear explanation as to why these have not been subsequently mapped.
SE	Yes	Yes	Yes	Yes	New maps have been produced for four major rivers with large dams. The dams are constructed for hydroelectric power plants, concerning the risk of failure of the dams.
SI	No				Considered with fluvial floods.
SK	No				
UK	Yes	Yes	Yes	Yes	Northern Ireland: maps for 156 reservoirs, each with a maximum capacity of 10,000 m^3 above natural level of surrounding ground. England and Wales: raised reservoirs greater than 25,000 m^3 assessed in terms of dam breach flood wave. This shows the maximum extent of flooding in the unlikely event that a reservoir should fail.

ni no information, relevant maps not checked.

Only a few Member States have mapped the potential hazard from floods arising from artificial water bearing infrastructure.

In the Brussels region of Belgium the flood hazard maps are based on historic floods. It is not specifically stated whether the floods mapped are pluvial, fluvial or from any other sources. However, it is mentioned that floods from watercourses and from sewers (the latter of which are included in the definition of artificial water bearing infrastructure used for reporting by Member States) are taken into account.

Lithuania has prepared flood hazard maps of areas that may be flooded due to failure of five dams (artificial water bearing infrastructure). These maps are not accessible to the general public because of safety considerations.

New maps have been produced for the risk of failure of the dams associated with artificial water bearing infrastructure in Sweden for four major rivers with large dams constructed for hydroelectric power plants. The flood hazard maps for the urban areas downstream of the dams are based on preparedness studies for reservoir dam failure. These studies have a more precise description of the regulation regime and river depth than the other flood hazard maps.

Areas at risk of flooding from large raised reservoirs (with a capacity over 25,000 m^3) were mapped in the UK (England and Wales) but no probabilities of flooding have been assigned. Flood modelling was undertaken to predict the arrival, depth, velocity, hazard and extent of flooding resulting from a dam breach flood wave corresponding to a full reservoir (i.e. equivalent to a 'credible worst case scenario'). Reservoirs are assumed to be full and overtopping at the time of modelled breach and the breach is assumed to occur over the full height of the dam/embankment. In the UK (Northern Ireland) the hazard elements included in the maps are not described. Maps have been produced for 156 reservoirs which are capable of holding in excess of 10,000 m^3 of water above the natural level of the surrounding ground. The maps are considered to represent a low probability flood (dam breach is not considered to occur under medium or high probability events) and are available to reservoir owners, operators and managers on request.

4.6 Summary of elements in hazard maps for different sources of flooding

Figure 4.7 summarises at the EU level the hazard elements used in hazard maps for different sources of flooding.

As has already been described, fluvial floods are mapped by the most Member States (25), the exceptions being Malta and Luxembourg[8] where this type of flood is not considered to be significant; Bulgaria has yet to report. All those Member States mapping fluvial floods include flood extent on their maps but two did not include water depth and only 12 considered water velocity as being appropriate for their maps. Slovenia gave a combined indication of water

[8] The LU Authorities subsequently indicated that fluvial floods had been mapped though only pluvial had been reported to WISE

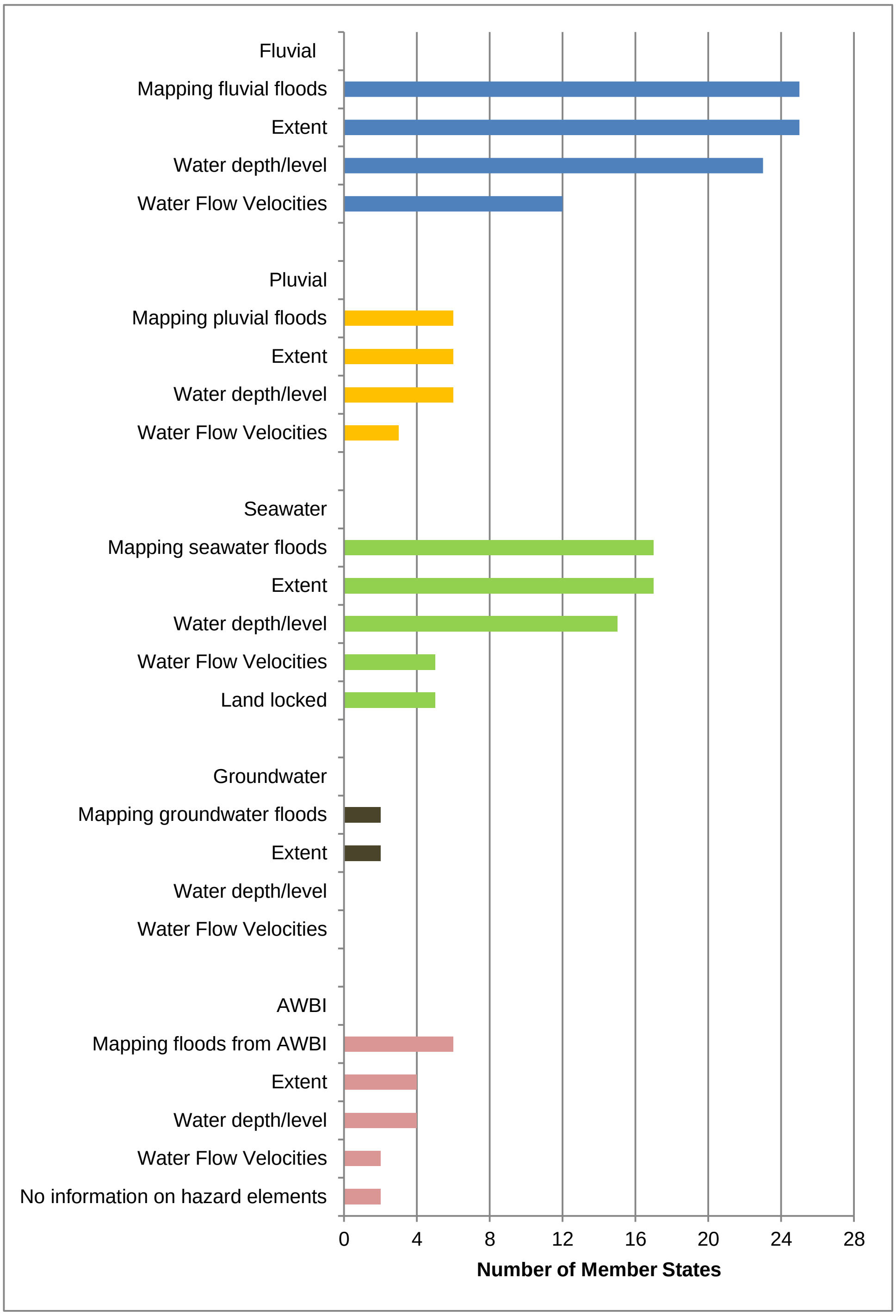
depth and water velocity on their maps. Latvia only showed flood extents on their fluvial hazard maps. Water depth and extent was shown on the flood maps in Denmark but not in relation to probabilities.

Seventeen of the 23 Member States with coastlines have mapped the hazard from sea water flooding: all of these include flood extent on their maps and fifteen also include flood depth/level. Slovenia combined water level and tidal currents on their hazard maps. Water flow velocity was only indicated on maps from five Member States.

Specific maps of pluvial floods were prepared by six Member States. For eight other Member States (EE, ES, FR, LT, NL, RO, SI and SK) this specific source was not distinguishable on the hazard maps and was combined with other sources (mainly fluvial) of flooding. All six Member States showed both flood extent and water depth on their maps. Water flow velocities were also shown on the pluvial maps of three Member States.

Groundwater floods and potential floods from artificial water-bearing infrastructure were mapped by relatively few Member States: 2 and 6, respectively.

Figure 4.7 Overview of elements used in mapping the hazards from different sources of flooding



Note: Hazard elements irrespective of the probability scenario being mapped

5. Methodologies used to prepare flood risk maps

Article 6.5 requires flood risk maps to show the potential adverse consequences associated with the flood scenarios referred to in Article 6.3 and expressed in terms of:

- the indicative number of inhabitants potentially affected;
- type of economic activity of the area potentially affected;
- potentially affected installations covered by the Industrial Emissions Directive;
- protected areas under the Water Framework Directive; and,
- other information and potential consequences which the Member State considers useful, such as the indication of areas where floods with a high content of transported sediments and debris floods can occur, and information on other significant sources of pollution.

5.1 Risk to human health

As an example, the indicative number of inhabitants potentially affected by each flooding scenario could be determined by counting the properties located within the flood extent and multiplied by the average occupancy rate per household. The counting of properties could be done over a specified standardised geographic scale or unit, for example, a 1 km^2 grid. Hotspots of populations at potential risk may then be identified by banding the geographical units into a number of categories (e.g. 1-50, 51-100, 101-500, 501-1000 and more than 1000 inhabitants per km^2).

Annex 3 summarises the relevant information reported by Member States to WISE on the approaches and methodologies used in their flood risk maps in terms of the potential effects on human health and inhabitants.

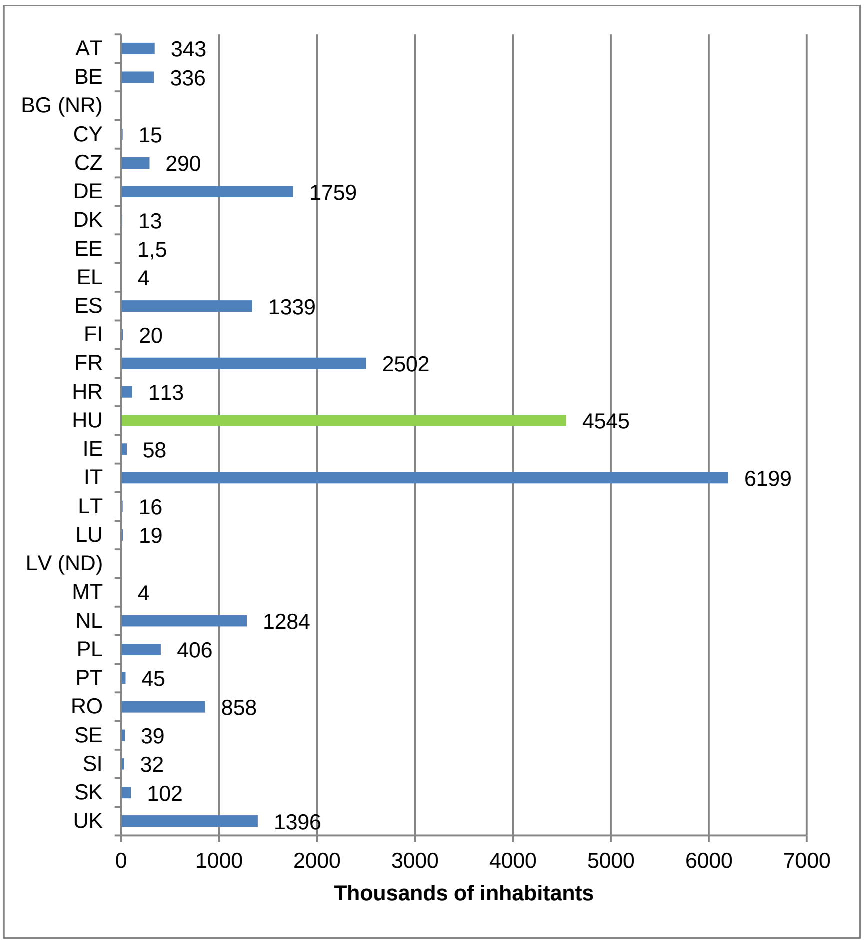
Geo-referenced population census data or registers are commonly used (AT, BE, EE, HR, IT) to determine the number of potentially affected inhabitants within hazard areas. Building registers are used (CZ) and these can be used to estimate the numbers of occupants based on average occupancy rates (e.g. from 2.2 to 2.5 people per residence in the three regions in the UK), from the actual number of occupants per residence (e.g. based on water bill records in MT) or generic assumptions on numbers of people for types of building or land use (e.g. 18 m^2/person to 70 m^2/person in CY). Population density maps have also been used (ES). The number of potentially affected inhabitants can be visualised in a number of categories (typically in 2 to 5 bands) and covering a wide range of values (maximum of >500 inhabitants in LU to 100,000 in HU), probably reflecting differences in the population densities between Member States, UoMs and flood hazard areas. Affected inhabitants can also be expressed in terms of numbers of people per unit area of the risk area (BE) or within an APSFR (LV).

Maps showing the potential impacts of flooding most often include an indication of the number of inhabitants potentially affected for each of the probabilities and sources of flooding. Potentially more inhabitants would be affected by flooding from low probability or extreme, rare events than from medium or high probability (more common) events.

Information is available from 24 Member States on the number of potentially affected inhabitants from medium probability fluvial floods. This information was reported by Member States in the FHRM schema (with GIS data) so that it can be visualised on EU scale flooding maps. It is presented as the sum of the numbers reported for all the APSFR or UoMs in the Member State: it equates to the very unlikely event of all risk areas in the Member State being affected by a medium probability fluvial flood at the same time. Note that the values for Luxembourg[9] and Malta relate to medium probability pluvial floods because fluvial floods were not considered as being significant. Also the value for Hungary is based on low probability fluvial floods, as medium probability fluvial floods were not reported. Because of differences in the probabilities of flooding and in the methods used to calculate the numbers of affected inhabitants, the numbers between Member States are not directly comparable but are intended to provide a general overview of the scale of the potential effect on exposed inhabitants.

[9] The LU Authorities subsequently indicated that fluvial floods had been mapped though only pluvial had been reported to WISE

Figure 5.1 Number of inhabitants potentially affected by medium probability fluvial floods at Member State level



Notes:
Source: data reported in the FHRM schema as of August 2015
HU – low probability fluvial flood – shown in green
MT and LU – medium probability pluvial flood
DK – medium probability sea water flood
EL – based on 1 UoM
SE – no source of flooding reported
ND – no data
NR – not reported

The information presented in Figure 5.1 is also summarised in Table 5.1 in terms of the minimum, average and maximum number of potentially affected inhabitants. These have been calculated from the values provided by Member States (in the FHRM schema uploaded to WISE) with the maps that are to be visualised on a European scale flood map. The number of potentially affected inhabitants has been reported for each APSFR and/or each UoM in the Member State for the relevant sources and probabilities of flooding. The calculated minimum, average and maximum values are those across the APSFR or UoMs in the Member State: they are not the minimum, average or maximum numbers within each APSFR or UoM. For example, the minimum number represents the APSFR with the lowest number of potentially affected inhabitants within the Member State.

Some Member States have reported potentially affected inhabitants by UoM rather than by ASPFR, particularly those applying Article 13.1.b such as Belgium, Italy and the Netherlands. The UK has applied both Article 4 and Article 13.1.b and has accordingly reported data by APSFR and by UoM. Luxembourg[10] and Malta only reported on the number of potentially affected inhabitants from medium probability pluvial floods, Denmark only for medium probability seawater floods, Estonia and Hungary only for low probability fluvial floods and Sweden reported on the number of potentially affected inhabitants from medium probability fluvial floods: the data from these Member States have been included in the Table below.

Table 5.1 Minimum, average and maximum number of potentially affected inhabitants across the APSFR or Units of Management in Member States from medium probability fluvial floods

MS	Minimum	Average	Maximum	Scale of data
AT(388)	0	885	65847	APSFR
BE(7)	68	48005	124825	UoM
BG(NR)				
CY(19)	10	781	6260	APSFR
CZ(3)	0	5986	40200	UoM
DE(806)	0	2183	177598	APSFR
DK(10)	96	1258	3834	APSFR
EE(7)	2	208	1086	APSFR
EL(2)	140	2170	4200	APSFR
ES(745)	0	2912	121279	APSFR
FI(17)	0	949	8740	APSFR
FR(45)	109	31383	793292	APSFR
HR(2288)	0	50	6976	APSFR
HU(1)	4,545,104	4,545,104	4,545,104	APSFR
IE(41)	0	1434	29924	APSFR
IT(46)	0	2096	666744	UoM
LT(4)	0	4090	15569	UoM
LU(15)	54	1266	5399	APSFR
LV(NR)				
MT(4)	461	1025	2517	APSFR
NL(4)	84088	320963	916052	UoM
PL(201)	1	1631	77290	APSFR
PT(15)	10	3010	9800	UoM
RO(349)	0	2459	61307	APSFR
SE(25)	0	1544	10584	APSFR
SI(41)	0	771	12750	APSFR
SK(519)	0	171	9763	APSFR
UK1 (263)	0	297	15640	APSFR
UK2 (11)	1144	73588	358195	UoM

Source: data reported in the FHRM schema

[10] The LU Authorities subsequently indicated that fluvial floods had been mapped though only pluvial had been reported to WISE

Numbers in brackets next to the MS abbreviation are the number of APSFR or UoM for which data have been reported
EE and HU – low probability fluvial flood
MT and LU – medium probability pluvial flood
DK – medium probability sea water flood
EL – based on 1 UoM
SE – no source of flood reported in the FHRM schema: the SE Authorities subsequently stated that the information was for fluvial floods.
UK1 – medium probability fluvial floods
UK2 –medium probability river and sea floods
NR – not reported

There are very large differences within and between Member States in the numbers of potentially affected inhabitants reflecting differences in the size and population densities of the flood risk areas. Hungary has reported one APSFR (the Danube River Basin District) and indicated that over 4 million inhabitants are potentially at risk from flooding whereas for some APSFRs in for example, Germany, Finland and the UK there are reported to be no potentially affected inhabitants. Existing flood defences and the effect of climate change are said to be considered by two Member States (EL, FI).

5.2 Risk to economic activity

Table 5.2 summarises the potential adverse consequences on economic activity reported by Member States to be associated with their medium probability floods (all sources). The adverse consequences were reported as a number of predefined “types” of economic activity in the electronic FHRM schema. Not all types would necessarily be expected to be associated with each flood risk area and/or UoM as the potential economic features at risk may not occur within the area of potential flooding being mapped. Member States were asked to provide specific data for their flood hazard and flood risk maps (in the FHRM schema) so that the adverse consequences associated with each map could be visualised on a European-scale map. GIS files of the risk area were also to be reported at the same time. As a minimum, medium probability flood maps were requested but low and high probability floods were reported by some Member States. This information was uploaded to WISE in the form of FHRM XML files which were compiled into a database with all the data from Member States.

Table 5.2 Number of units of management within a Member State where the potential adverse consequences on economic activity have been included in mapping the risk from medium probability floods (all sources considered).

MS	Property	Infrastructure	Rural Land Use	Economic Activity	Other economic	Not applicable*
AT (2)	2	2	2	2		
BE (7)	7	7	6	7	3	
BG	Not reported					
CY (1)	1	1	1	1		
CZ (3)	3	3	2	3		**2**
DE (10)	9	9	9	9	3	**1**
DK (2)	2	2	2		2	

MS	Property	Infrastructure	Rural Land Use	Economic Activity	Other economic	Not applicable*
EE (2)(L)	2	2		2		
EL (1)	1	1	1			
ES (25)	25	25	25	25	8	**15**
FI (6)		6			2	**2**
FR (12)	12	11	6	12	8	**1**
HR (2)	2	2	2	2	2	**2**
HU (1) (L)	1	1	1	1		
IE (10)	10	10	10	10		
IT (47)	46	45	46	46	4	**20**
LT (4)	4	4	4	4	4	
LU (1)	1	1	1	1		
LV (1)	1	1	1	1		
MT (1)				1		
NL (4)	4	4	4	4	4	
PL (3)	3	3	3	3	3	
PT (15)	15	15	9	12		
RO (12)	12	12	12	12		
SE (6)	6	6	6	5		
SI (2)	2	2	2	2	2	**2**
SK (2)	2	2	2	2	2	
UK (15)	15	15	12	5	11	**2**

Source: data reported in the FHRM schema as of August 2015
L = low probability maps
The number of UoMs in which hazard areas have been reported is shown in the brackets next to the Member State abbreviation
Property: Adverse consequences to property, which could include homes.
Infrastructure: Adverse consequences to infrastructural assets such as utilities, power generation, transport, storage and communication.
Rural Land Use: Adverse consequences to uses of the land, such as agricultural activity (livestock, arable and horticulture), forestry, mineral extraction and fishing.
Economic Activity: Adverse consequences to sectors of economic activity, such as manufacturing, construction, retail, services and other sources of employment.
Other economic: Adverse consequences to any other economic activities not included in other definitions
Not applicable: Hazard areas where economic consequences were not applicable

Of the 27 Member States that reported the data associated with their maps to WISE in the FHRM schema, only Malta did not indicate potential adverse consequences on infrastructure; two Member States (Finland and Malta) did not indicate potential adverse consequences on property. Nine Member States had at least one UoM with hazard areas where economic consequences were not applicable.

The consideration and assessment of the risk to economic activity from flooding may be undertaken in a number of ways and consider a number of different sensitive receptors. For example, a direct economic assessment of flood risk may have been undertaken using a national depth/damage assessment methodology which provides a count of properties affected as well as damage figures for each of the probability flood events. The type of roads impacted within a flooded extent, or the length of road affected may also have been calculated, with only roads located within flood waters above a depth threshold of 0.15 m being mapped (as it is at this depth that a Member State might consider driving becomes difficult and dangerous). The number and length of railway lines impacted by flooding may also have been assessed when they were located within a flood area. For agricultural land at risk, direct damages may have been assessed in terms of the one-off loss of crops/harvest for each return period.

Typical, aggregated depth-damage functions can be attributed to land use types, differentiated by CORINE Land Cover. In the UK, depth-damage relationships have been established for different land use and property classes using research and evidence of flooding over many years, looking at the economic losses incurred. Economic damage, direct and indirect, and internal damage (combination of flood hazard levels and socio-economic data) can be expressed in terms of €/year or €/km^2. Potential damage evaluation is a monetary (and sometimes non-monetary) evaluation of impacts on people at risk, land use, infrastructure, property and assets.

Annex 4 summarises the relevant information reported by Member States to WISE on the approaches and methodologies used in their flood risk maps in terms of the potential effects on economic activity.

Land use maps are used by a number of Member States (BE, CZ, DE, ES, PL) with 7 (AT, EL, HR, HU, IT, LU, RO) making specific reference to CORINE Land Cover maps. National spatial planning maps and information (CY, EE, ES, LV), and national registers of infrastructure and buildings (AT, IE, SI) are also commonly referenced as being used. Flood damage or flood depth functions are reported to be used in assessing risk for seven Member States (DK, LT, LV, PL, RO, SE, UK). Existing flood defences and the effect of climate change are said to be considered by two (EL, FI).

5.3 Risk to Installations covered by the requirements of the Industrial Emissions Directive (IED) or previously under the IPPC Directive

Member States are required to assess the risk from Integrated Pollution Prevention and Control (IPPC) Directive or Industrial Emissions Directive (IED) installations which might cause accidental pollution if any type of flood occurred. The focus of the risk assessment may be on activities or installations with a high pollution potential through the release of pollutants into water or land rather than those that potentially only release pollutants into the air.

Table 5.3 summarises the number of IED/IPPC installations reported by Member States to represent a potential source of pollution from medium and low probability floods. Not all UoM/flood hazard areas would necessarily be expected to have installations that represent a risk of pollution from flooding. Italy reported by far the largest number (1935) of potentially affected IED installations from medium probability fluvial floods, Malta reported none and four Member States reported only one installation in their UoMs/flood hazard areas.

Table 5.3 Number of IED installations reported by Member States to be affected by low and medium probability fluvial floods

MS	Number of affected IED installations	
	Medium Probability	Low Probability
AT	2	NR
BE	21	76
BG	Not reported	
CY	1	2
CZ	41	NR
DE	284	1 (1 UoM only)
DK	Unknown	
EE	NR	7
EL(3)	0	0
ES	172	242
FI	4	7
FR	163	NR
HR (4)	12	NR
HU	NR	190

MS	Number of affected IED installations	
	Medium Probability	Low Probability
IE	1	NR
IT	1935	NR
LT	2	NR
LU (1)	1	3
LV	1	1
MT (1)	0	NR
NL	203	987
PL	214	NR
PT	7	7
RO	25	9 (1 UoM only)
SE(2)	10	NR
SI	9	15
SK	4	NR
UK	59	NR

Source: data reported in the FHRM schema
NR Not reported
1 Pluvial floods
2 Source not reported, medium probability. SE Authorities subsequently stated that this is for fluvial floods.
3 One UoM reported only
4 All flood sources

Annex 5 summarises the relevant information reported by Member States to WISE on how installations that represent a source of potential pollution when flooded were identified.

Most Member States included other types of installation/sources that may represent a potential source of pollution in the case of flooding. This includes Seveso sites (AT, BE, FI, HR, HU, IT, LU, PL, PT, SI, SK), waste water treatment works (AT, FI, HR, HU, PL, SI), landfills (BE, HR, PL, SI), fuel/chemical storage facilities (FI), abandoned hazardous sites (AT), and former IED licensed installations (IE). There was also categorisation of the relative level of risk represented by a potentially affected installation or site in two Member States: e.g. sources with potential releases to air, land and water were prioritised over those with releases only to air in the UK; and the assessment of significance of the risk from abandoned sites depended on the level of restoration that had been undertaken in Austria. Other Member States (CY, SE, SI) did not distinguish between the environmental pathways (e.g. to land and/or to water) from affected sites in their assessment of risk of pollution from flooding. Geo-referenced databases on installations were often used to identify those potentially affected by flood extents (CZ, ES, FR, IT, LU, NL). In at least two Member States (DE and UK), a distance from potential flooded areas was used in the selection of significant installations: within 200 m of predicted flood extents in DE and 50 m in the UK.

5.4 Potential adverse consequences on the environment

Member States were asked to report on the mapping of the potential adverse consequences of flooding on the environment (Table 5.4). Environmental consequences included permanent or long-term consequences on the ecological or chemical status of affected surface water bodies or chemical status of ground water bodies, as defined under the WFD (Water Body Status in Table 5.4). Such consequences may arise from pollution from various sources (point and diffuse) or due to hydromorphological impacts of flooding. Also to be considered are the adverse permanent or long-term consequences to protected areas or water bodies such as those designated under the Birds and Habitats Directives, bathing waters or drinking water abstraction points (Protected Areas in Table 5.4). Pollution Sources were also to be reported in terms of potential pollution in the event of a flood, such as IPPC and Seveso installations, or point or diffuse sources (Pollution Sources in Table 5.4).

Table 5.4 Number of units of management within Member States where the potential adverse consequences on the environment have been included in the mapping of the risk from medium probability floods (all sources considered)

MS	Water Body Status	Protected Areas	Pollution Sources	Other environment	Not applicable
AT (2)		2	2		2
BE (7)	4	7	7		
BG	Not reported				
CY (1)			1		1
CZ (3)		3	3		3
DE (10)	6	9	6		3
DK (2)					2
EE (2)(L)	2	2	2		
EL (1)		1			
ES (25)	25	25	21	1	20
FI (6)	2	3	5		3
FR (12)		7	9		10
HR (2)		2	2		2
HU (1)(L)	1	1	1		
IE (10)		10	2		1
IT (47)	16	33	33	5	43
LT (4)		4	1		
LU (1)	1	1	1		
LV (1)		1	1		1
MT (1)					1
NL (4)		4	4		
PL (3)		3	3		2
PT (15)			7		8
RO (12)		12	11		10
SE (6)	1	6	5		1
SI (2)		2	2		2
SK (2)	2	2	2		2

MS	Water Body Status	Protected Areas	Pollution Sources	Other environment	Not applicable
UK (15)	11	12	12	11	5

Source: data reported in the FHRM schema as of August 2015
L - Low probability maps
The number of UoMs in which hazard areas have been reported is shown in the brackets next to the Member State abbreviation.

Waterbody Status	Adverse consequences ecological or chemical status of surface water bodies or chemical status of ground water bodies affected, as of concern under the WFD. Such consequences may arise from pollution from various sources (point and diffuse) or due to hydromorphological impacts of flooding.
Protected Areas	Adverse consequences to protected areas or water bodies such as those designated under the Birds and Habitats Directives, bathing waters or drinking water abstraction points.
Pollution Sources	Sources of potential pollution in the event of a flood, such as IPPC and Seveso installations, or point or diffuse sources.
Other environment	Other potential adverse environmental impacts, such as those on soil, biodiversity, flora and fauna, etc.
Not applicable	Environmental consequences are not applicable for some hazard areas or APSFR within the UoM

Two Member States (MT and DK) indicated that environmental consequences were not applicable in any of their UoMs: 18 other Member States reported that environmental consequences were not applicable in some of their UoMs. Only 11 of the 27 Member States that reported indicated that adverse consequences on the status of WFD water body status were relevant. Most Member States (23) reported potential adverse consequences on protected areas and 24 indicated that pollution sources were potentially significant for medium probability floods.

According to the guidance on the reporting of spatial data for the Floods Directive[11], Member States were expected to report information on their medium probability flood maps, and, where applicable (i.e. where Article 6.6 or 6.7 had been applied) for coastal and groundwater floods for the low probability scenario. Table 5.5 summarises where Member States have reported the potential adverse consequences on the environment from low probability floods.

Table 5.5 Number of units of management within Member States where the potential adverse consequences on the environment have been included in the mapping of the risk from low probability floods (all sources considered)

MS	Water Body Status	Protected Areas	Pollution Sources	Other environment	Not applicable
AT	Not reported				
BE (7)	4	5	5		
BG	Not reported				
CY (1)			1		1
CZ	Not reported				
DE (10)	2	3	2		1
DK	Not reported				
EE (2)	2	2	2		
EL (1)		1			
ES (25)	18	25	21	1	20

[11] Reporting of spatial data for the Floods Directive, (Part II): Guidance on reporting for flood hazard and risk maps of spatial information; Version 5.1, December 2013

MS	Water Body Status	Protected Areas	Pollution Sources	Other environment	Not applicable
FI (6)	2	4	5		2
FR	Not reported				
HR	Not reported				
HU (1)	1	1	1		
IE	Not reported				
IT	Not reported				
LT	Not reported				
LU (1)	1	1	1		
LV (1)		1	1		1
MT	Not reported				
NL (4)		4	4		
PL (3)		2	2		2
PT (15)			7		8
RO (12)		1	1		
SE	Not reported				
SI (2)		2	2		2
SK	Not reported				
UK	Not reported				

Source: data reported in the FHRM schema as of August 2015
The number of UoMs in which hazard areas have been reported is shown in the brackets next to the Member State abbreviation.

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

Fifteen Member States provided information on low probability flood maps, 14 indicated that adverse consequences from pollution sources were relevant; 13 also indicated that there were potential adverse consequences on protected areas; and 7 indicated adverse consequences on water body status.

5.5 Type of Protected Areas that are potentially at risk from flooding

Table 5.6 shows the type of Protected Areas that might be adversely affected by medium probability fluvial flooding in Member States that reported to WISE. Twelve of the 25 Member States that reported information did not specify which types of Protected Areas (if any) might be adversely affected by medium probability fluvial floods. Ten of the 12, however, had reported potential adverse consequences on Protected Areas in general (see Table 5.4).

All types of Protected Areas were potentially impacted in some UoMs in Spain and Italy. The most commonly reported Protected Areas potentially at risk were Habitats Directive (14 Member States) followed by Birds Directive Protected Areas (12 Member States); the least commonly reported were Nitrate and UWWT Directive sensitive waters (5 Member States each).

Table 5.6 Number of units of management within Member States where there are reported potential adverse consequences on the different types of Protected Areas from medium probability fluvial floods

Member State	Type of Protected Area									
	1	2	3	4	5	6	7	8	9	10
AT (2)										
BE (7)	1			1						
BG (NR)										
CY (1)			1	1						
CZ (3)										
DE (10)										
DK (2)										
EE (2) (L)		1		1		1				
EL (1)	**1**	**1**	**1**	**1**						
ES (25)	15	14	14	17	1	9	3	10	2	3
FI (6)	3	2	1	2				1		
FR (12)										
HR (2)										
HU (1) (L)		1	1	1			1		1	
IE (10)	10	3	6	10						
IT (47)	17	9	26	28	18	15	9	19	7	18
LT (4)	3	3	4	4	4	4				
LU (1) (P)	1		1	1	1	1		1		
LV (1)	1	1	1	1	1					
MT (1)										
NL (4)										
PL (3)										
PT (15)										
RO (12)	12		12	12					11	
SE (6)										
SI (2)	2	1	2	2					2	2
SK (2)										
UK (15)										

Source: data reported in the FHRM schema
Key to Protected Areas
1 Article 7 Abstraction for drinking water
2 Bathing
3 Birds
4 Habitats
5 Nitrates
6 UWWT
7 European Other
8 WFD Water Body status
9 National
10 Local
NR = Not reported

L = Low probability fluvial flood
P = Medium probability pluvial flood
The number of UoMs in which hazard areas have been reported is shown in the brackets next to the Member State abbreviation

The assessment of the potential adverse consequence on Protected Areas could start by identifying whether any are present in the predicted inundated area and, if so, whether they could be affected by pollution from any potentially flooded IED/IPPC installation. The assessment of risk could consider travel and dispersion patterns of pollutants potentially released from inundated installations to protected areas, and their sensitivity to the pollutants. Annex 6 summarises the approaches reported to be used by Member States to assess these potential consequences.

In general Member States indicated that geo-referenced information on the location of Protected Areas was overlain or compared with flood inundation areas to identify those that occurred in potentially flooded areas. However, there was very little reported information on how the subsequent impact on the flood-affected Protected Areas was assessed or if it was at all. Some general information was provided by the UK (Scotland) where the travel and pollutant dispersal patterns from floodwater-inundated IPPC installations to Protected Areas were assessed, though there was no information on what subsequently equated to a significant impact on the affected Protected Areas or water bodies.

5.6 Other adverse consequences considered

The potential adverse consequences on cultural heritage were also considered in the risk maps produced by Member States. Cultural heritage could be reported generically or it could be disaggregated into cultural assets such as archaeological sites/monuments, architectural sites, museums, spiritual sites and buildings or landscape and other cultural heritage. Additionally, other information which the Member State considers useful can be included in the flood risk maps, such as the indication of areas where floods with a high content of transported sediments and debris floods can occur and information on other significant sources of pollution.

Table 5.7 shows that only a few Member States reported adverse consequences on cultural heritage: 13 out of the 27 Member States reported adverse consequences on cultural assets, 6 with adverse consequence on landscape.

Table 5.7 Number of units of management within a Member States where the potential adverse consequences on cultural heritage have been reported with medium probability flood maps

MS	Cultural Heritage (generic)	Cultural Assets	Landscape	Other cultural heritage	Not applicable
AT (2)					
BE (7)		3	2		

MS	Cultural Heritage (generic)	Cultural Assets	Landscape	Other cultural heritage	Not applicable
BG	Not reported				
CY (1)		1			
CZ (3)					
DE (10)	**4**				**1**
DK (2)		2			
EE (2)(L)					
EL (1)					**1**
ES (25)		23	6		**6**
FI (6)		4	1		**6**
FR (12)					
HR (2)					
HU (1)(L)					
IE (10)					
IT (47)		38	30	1	**14**
LT (4)		4			
LU (1)					
LV (1)		1	1		**1**
MT (1)					
NL (4)					
PL (3)					
PT (15)		14			**1**
RO (12)		12			
SE (6)		6	6		
SI (2)		2			**2**
SK (2)					
UK (15)					

Source: data reported in the FHRM schema as of August 2015
L = Low probability maps
The number of UoMs in which hazard areas have been reported is shown in the brackets next to the Member State abbreviation.

Cultural heritage (Generic)	Specific types not reported
Cultural Assets	Adverse consequences to cultural heritage, which could include archaeological sites / monuments, architectural sites, museums, spiritual sites and buildings.
Landscape	Adverse permanent or long-term consequences on cultural landscapes, that is cultural properties which represents the combined works of nature and man, such as relics of traditional landscapes, anchor locations or zones.
Other cultural heritage	Other than those defined above
Not applicable	Adverse consequences to cultural heritage assessed as not being relevant

The information in Table 5.7 does not always tally with that summarised in Annex 7 on the approaches used by Member States in identifying adverse consequences on cultural heritage. This is because the Table is based on the numeric data reported with the maps in the FHRM schema and the Annex is based on the summary methodological information reported to WISE by Member States. For example, cultural heritage sites are said to be included in flood maps in AT, CZ, FR, HR, IE (maps being developed), NL, PL and UK, though these consequences were not reported to WISE.

In terms of other potential consequences, areas in which floods may carry a high amount of material/debris, i.e. alpine creeks with irregular course and heavy current, are marked on the maps by linear markings along the course of the water body in Austria. In Denmark an assessment for areas at risk from large amounts of sediments and floating refuse carrying pollution was undertaken, but no risk areas were identified. Mapping of the areas potentially affected by debris flows was carried out in Italy. For one UoM in Sweden (SE5) areas prone to erosion and landslides were considered, but not included, because of the lack of a unified method to show these areas on maps.

6. Justification for applying Article 6.6

For coastal flooding where there is an adequate level of protection in place, Member States can decide to limit the preparation of flood hazard maps to low probability or extreme events (Article 6.6). The Member States applying this Article are Germany (DE3000, DE4000, DE5000 and DE6000) and Poland (PL2000 and PL6000). It would be expected, therefore, that these Member States would have assessed whether or not the existing flood defences are providing an adequate level of protection for both medium and high probability floods. Table 6.1 summarises the information reported to WISE on these aspects.

Table 6.1 Summary of justifications reported by Member States for the use of Article 6.6

Justification for the use of Article 6.6	Yes	No	No information
Risk of failure of existing flood defences assessed	DE, PL		
Risk of overtopping of existing flood defences assessed	PL		DE
The level of protection was determined to be adequate in terms of:			
• people potentially affected	DE		PL
• different types of economic activities in the areas potentially affected	PL		DE
• potential adverse consequences in relation to IED installations	PL		DE
• Potentially affected protected areas identified under the WFD	PL		DE
• Elements of cultural heritage that might be potentially affected	PL		DE
• Other potential consequences		DE	PL

In Germany there was no direct statement for what flooding probabilities the existing flood defences were considered to be adequate. However, existing flood defences are used as an argument for using Article 6.6 so it can be assumed that they are considered to be adequate for high and medium probabilities.

Medium probability maps in addition to low probability maps have been produced in Poland even though the use of Article 6.6 has been reported: the reason for this is not clear. High probability flood maps were not produced because the existing defences protect the potentially affected areas. Poland reports that there is a multiplicity of programmes, plans and laws to maintain adequate protection for the coastal areas. A coastal belt concept that includes a zone of direct impact from flooding from the sea and land has been used. The entire length of the sea coast (including the ports and harbours) is fully protected against flooding from the sea with a 5% probability of occurrence. The coastal flood maps do not include information on the level of protection determined to be adequate in terms of people potentially affected. Although these are referred to in the methodology, they are not presented on the maps. The maps include information on the different types of economic activity, consequences in relation to IED installations, protected areas and cultural heritage.

The PL Authorities subsequently stated that it may have not been appropriate to apply Article 6.6 in Poland.

Although the Netherlands did not report the use of Article 6.6 in any of its UoMs, the NL Authorities said that where there are flood defences in place, the low probability scenario has only been modelled because of the high safety standards applied for primary coastal flood defences (which protect against 1/4000 and 1/10000 year events). All three probability scenarios were modelled for the unprotected areas along the Netherlands coast.

7. Justification for applying Article 6.7

For groundwater flooding, Member States can decide to limit the preparation of flood hazard maps to low probability or extreme events (Article 6.7). The Member States applying this Article are Germany (DE2000, DE9500 and DE9610), Hungary and the UK (UK01 and UK02).

The justifications for the application of this Article were assessed from the MS reports to WISE and are summarised in Table 7.1.

Table 7.1 Summary of justifications reported by Member States for the use of Article 6.7

Justification	Member States to which the justification applies
Groundwater is considered as a contributing source rather than as a main source of flooding	DE, HU, UK
It is difficult to distinguish the impact of groundwater flooding from other sources of flooding	HU, UK
There is limited information or historical records on groundwater flooding	UK
Only low probability groundwater flooding is assessed to be hazardous or a risk	HU

In all three Member States, flooding from groundwater was considered as only a contributory source rather than a main source of flooding and it is difficult to distinguish the impact of groundwater flooding from other sources (HU, UK).

The only other Member State to prepare specific maps of groundwater flooding was Belgium (Brussels region), where Article 6.7 was not applied and three probability scenarios were mapped.

8. Application of Article 13.1.b in accordance with requirements of the Floods Directive

According to Article 13.1.b Member States may decide not to undertake the preliminary flood risk assessment referred to in Article 4 for those river basins, sub-basins or coastal areas where they have decided, before 22 December 2010, to prepare flood hazard maps and flood risk maps and to establish flood risk management plans in accordance with the relevant provisions of the Floods Directive.

Four Member States have applied this Article at the country level: Belgium, Italy, the Netherlands and Portugal; Germany has applied it in a number of UoMs (DE2000, DE4000, DE5000 and DE6000) along with other articles. The UK has applied it to specific types of flood in England and Wales e.g. floods from rivers and the sea, and from raised reservoirs.

The SK Authorities subsequently stated that Article 13.1.b has been applied to 29 areas: in total Slovakia identified 383 APSFR under Article 5. Note that maps of these specific areas have not been specifically checked against the requirements of the Floods Directive and hence are not included in the assessment described in this section.

The relevant provisions of the Directive may include:

- Relevant information considered and methodologies used to prepare maps; flood hazard maps and flood risk maps contain the relevant scenarios (Article 6.3) and data (Article 6.4 and 6.5);
- Potential adverse consequences have been identified and presented in flood risk maps (Article 6.5);
- The justifications for applying Articles 6.6 (coastal areas) and 6.7 (groundwater floods) if applied;
- Maps are prepared at the level of the UoM and at the most appropriate scale for flood risk areas (Article 6.1);
- The preparation of the maps was subject to prior information exchange between Member States in the case of international RBDs or UoMs (Article 6.2);
- Maps are made available to the public (Article 10.1).

8.1 Maps are prepared at the level of the UoM and at the most appropriate scale for flood risk areas

Flood maps intended to raise public awareness should enable anyone to find out where there are risks of flooding. Maps for this purpose may have a relatively larger scale e.g. 1: 10,000 to 1: 25,000 compared to those used for national or regional planning purposes (1:100,000 to 1:500,000). Also the mapping of some hazard features such as flow velocity may require a more detailed scale such as 1:1,000 or 1:5,000.

In Belgium, all UoMs have digital flood hazard and flood risk maps at the level of the UoM. However, there is no indication as to which flood sources are considered: all maps indicate 'floods' in general. All maps can be viewed at different scales and it is possible to zoom in up to a large scale: Brussels: 1:18,480; Flanders to 1:2,500; and, Wallonia: some layers to 1:5,000 others to 1:25,000.

In Germany, the use of Article 13.1.b was reported (in WISE) in DE2000 and DE4000. However there was no link between the specific risk area codes and the maps published. It could be assumed that the information for these areas is the same as for those developed in accordance with Article 4 as each Land followed the same approach within its territory: it is recommended that this is discussed between Germany and the European Commission.

In Italy maps were prepared for each UoM coinciding with the different kinds of basin identified. The basins can be national, (i.e. when the river basin covers more than two regions); regional (i.e. entirely within a single region) and inter-regional, (i.e. when the river basin is shared between two regions). Not all sources of flood were identified on the maps, but only the ones considered to be relevant. Although from the methodology for developing the hazard maps it seems that fluvial and pluvial floods have been considered together, this is not explicitly explained, nor graphically represented on the maps. Coastal floods were explicitly identified only in a few UoMs, but there is less detail available than for the fluvial floods. Different scales have been used in different UoMs, although it is not explicitly explained why. The maps at a more detailed scale depict hazard elements (1:5,000 for some areas), which are not visible in other maps with a larger scale (1:10,000 for other areas).

The IT Authorities subsequently stated that the use of different scales for the maps is related to the scale of the base map adopted to report flooded areas, risk level or exposed elements. The Legislative Decree transposing the Directive into Italian law establishes that the preferable scale is 1:10,000 with a scale smaller than 1:25,000 being mandatory.

Only 'floods in general' have been mapped in the Netherlands in all four UoMs. The geographic extent covers the whole of the Netherlands. Specific UoMs can be viewed and there are other options such as provinces, postal codes or roads. There is the possibility to view the information for any given location in the Netherlands. The navigation is very user-friendly and it is easy to zoom in or out or to type in a specific location. The maximum scale for mapping affected populations is 1:50,000 and 1:1,000 for other elements.

Flood hazard and flood risk maps have been produced for all areas considered relevant in mainland Portugal and the Azores. The 27 areas identified for the Madeira region are not yet published. The scale of all the maps accessible online varied from 1:2,080 to 1:8,333 which allows details of the affected areas to be visualised.

Article 13.1.b is only applied in England and Wales in the UK for the main rivers, large raised reservoirs and sea water. Links to the hazard maps go to a web viewer with an area slightly larger than the UoM displayed. No UoM boundaries are defined or visible on the maps. Flood risk maps that are available as PDF documents are produced at the UoM level. The scale of maps is generally consistent between the UoMs. The flood hazard maps are zoomed out too far at their initial use and flooding extent cannot be seen. However, this is easily rectified by the user zooming in to areas of interest. The flood risk maps are produced at a larger scale which is more appropriate to show the detail present.

8.2 Preparation of the maps subject to prior information exchange in the case of international RBDs or UoMs

In Belgium there is a lot of consultation between the Member States' and Unit of Managements' Authorities associated with the international RBDs. For the Meuse and Scheldt UoMs there has been multilateral coordination under the Meuse Treaty and Scheldt Treaty which were concluded in 2002. For all UoMs in the Netherlands, there were intensive bilateral and multilateral (if necessary) meetings with the other Member States. This was mainly to make mapping processes and output uniform for the transboundary UoMs. Only for the Rhine, are there discrepancies on adjoining maps for water depths and perimeters in the border area. This is expected to be resolved in future discussions. The prior exchange of information for example, for the Meuse was done in great detail using all available data including exchange of modelling exercises.

There was information reported on this aspect from Portugal; however no flooding areas are considered to be transboundary. Similarly in England and Wales (UK) there are no transboundary flood hazard areas even though there has been exchange of information with the Irish Authorities in the transboundary RBDs/UoMs.

No information was found with regard to the exchange of information between international UoMs in Italy and it was indicated that there were no international flood risk areas in the territory: note Italy had previously reported that there are two international UoMs (see Section 10) and so it is assumed that there are no shared flood risk areas within those areas. The IT Authorities subsequently stated that they had been in communication with the European Commission on this aspect.

Germany has indicated that that there was prior exchange of information in the preparation of maps for shared international flood risk areas but it is not clear whether this was the case for areas for which Article 13.1.b has been applied.

8.3 Maps produced for all required flooding scenarios for all sources that are a significant risk

All the Belgian maps are for 'floods' in general and all required scenarios were taken into account. Flooding from groundwater, artificial water bearing structures and sewerage systems were assessed as not significant.

In the Netherlands no distinction was made between the various sources of flood on the maps though all relevant sources (fluvial, sea water and from artificial water bearing infrastructure) were taken into account when preparing flood maps.

Italy provided detailed information in the FHRM schema on fluvial floods that could be visualised on EU scale maps for all 47 of their UoMs, for 26 UoMs for sea water floods, for 1 UoM for pluvial flooding and for 1 UoM for floods from artificial water bearing infrastructure: these latter two sources were mainly for the medium probability scenario. The maps represent the sources that have been assessed as being significant in each of the UoMs. Medium probability scenarios were mapped for pluvial floods and floods from artificial water bearing infrastructure, and all 3 scenarios were mapped for fluvial and sea water floods.

Apparently the only source of flood in Portugal is fluvial, with some of those influenced by tides in estuaries. The relevant scenarios were mapped for this source of flood.

River and coastal flooding maps have been prepared at low, medium and high probabilities in the UK in England and Wales for which Article 13.1.b has been applied. Flooding maps are produced for one scenario involving the breaching of raised reservoirs; other scenarios were not considered as being relevant.

The situation in Germany is not clear as the specific areas to which Article 13.1.b applies within each UoM have not been identified in the available reports.

8.4 Inclusion of required elements in hazard maps for each scenario

For the Brussels region of Belgium, only flood extents were mapped for all scenarios, whereas in Flanders and Wallonia, all hazard elements were mapped (for a list of the required hazard elements, refer to Section 4.1.2 of this report). In the Netherlands, flood extent and water depth were mapped, and flow velocity where appropriate. Not all of the assessed maps in Italy showed all the required hazard elements. For some areas, hazard information is shown in a table at the bottom of the map, for other areas all three hazard elements are shown and water extent is only shown in some other areas. Flood extent, water depth and flow velocities are mapped for fluvial, coastal and reservoir flooding under each scenario in the parts of the UK in which Article 13.1.b has been applied. The published maps in Portugal contain extent, water depth or level and flow velocity.

The situation in Germany is not clear as the specific areas to which Article 13.1.b applies within each UoM have not been identified in the available reports.

8.5 Inclusion of adverse consequence in risk maps for each scenario

For the Brussels region of Belgium all the required adverse consequences are shown (affected inhabitants are not presented as numbers but by pie charts) (a list of the required adverse consequences is provided at the start of Section 5). For Flanders, IPPC installations and WFD protected areas are clearly indicated on the maps. All the required adverse consequences are shown in the maps for Wallonia. All required adverse consequences (except cultural heritage which is not required) were mapped in the Netherlands' maps.

In Italy not all the assessed maps showed the required adverse consequences. For some of the checked areas, such information is provided in separate potential damage maps, although not all required adverse consequences were identified. Other checked areas did not provide any of the adverse consequences.

There are three sets of risk maps for England and Wales in the UK: one each for risk to people, risk to economic activity and risk to the natural and historic environment. Risk maps have been created for reservoir flooding and fluvial and coastal flooding (the latter two also including the various probabilities of flooding).

The published maps in Portugal contain affected inhabitants, areas of affected economic activity and installations. However, there is no clear depiction of WFD Protected Areas, though Natura 2000 and Ramsar sites were considered and mapped.

The situation in Germany is not clear as the specific areas to which Article 13.1.b applies within each UoM have not been identified in the available reports.

8.6 Making the flood hazard and flood risk maps available to the public

In Belgium the webpages where the maps can be consulted are easy to find, and in the Netherlands all flood hazard and flood risk maps in all UoMs are available to the public. The geographic extent covers the whole of the Netherlands. The navigation is very user friendly-easy to zoom in or out or type a location.

In Italy, generally the maps are available to the public through the websites of the regional/national river basin authority or the regional authority. For the majority of the UoMs assessed, maps were available in PDF format. In many cases PDFs are available for several polygonal sections of the water body (sometimes even 100 polygonal sections) and each of them must be downloaded in zip files. This may prove as a barrier to the general public. Only one of the UoMs assessed provides the map via a web viewer, although this is very slow in uploading and slow in changing from one layer to another, which means it is not very user friendly. For two of the areas selected for checking the web link of the WebGIS did not work and for one it seemed to be protected and therefore not available to the public.

In England and Wales in the UK, the Environment Agency website hosts the flood maps which are available to the public via a map viewer. In addition, PDF versions of risk maps are available to the public from the UK Government's website.

At the time of the assessment, not all the maps for Portugal were publicly available. At a public participation event, it was stated that the maps for mainland Portugal were undergoing final adjustments. For the Madeira region there is no indication on when the maps will be made available.

The situation in Germany is not clear as the specific areas to which Article 13.1.b applies within each UoM have not been identified in the available reports.

8.7 Summary of application of Article 13.1.b in accordance with the requirements of the Floods Directive

Table 8.1 summarises the information presented in the previous sections in terms of whether maps prepared by those Member States applying Article 13.1.b have done so according to the requirements of the Floods Directive.

The information found for Germany is not clear because the areas within each UoM to which Article 13.1.b applies have not been specifically identified in the maps or in the reported WISE information. However, it may be assumed that the information for these areas is the same as those developed in accordance with Article 4 as each Land followed the same approach in its territory.

Of the Member States applying this Article, the Netherlands and the UK seem to have met all the required provisions of the Directive whereas for the other Member States the meeting of some of the provisions is not clear and /or they are not applied to all flood risk areas, scenarios or all significant flood sources.

Table 8.1 Summary of information presented in flood maps by Member States applying Article 13.1.b

Provision of the Directive	BE	DE (1)	IT	NL	PT	UK (2)
Maps prepared at the level of the UoM and at the most appropriate scale for flood risk areas	Yes	Not clear	Yes	Yes	Yes	Yes
Prior information exchange on preparation for maps in international transboundary risk areas	Yes	Not clear	Not clear	Yes	Not clear	Not relevant in England & Wales
All required flooding scenarios for all significant sources mapped	Sources not clear	Not clear	Not clear	Yes	Yes	Yes
Hazard elements included on maps for each scenario	Yes but not for all UoMs	Not clear	Yes but not for all UoMs	Yes	Yes	Yes
Adverse consequences included in risk maps for each scenario	Yes	Not clear	Yes but not for all UoMs	Yes	Not all	Yes
Flood hazard and flood risk maps made available to the public	Yes	Not clear		Yes	Not all yet	Yes
Justifications for applying Articles 6.6 and 6.7	Not applied	(3)	Not applied	Not applied (4)	Not applied	Not applied

1 For areas within UoMs DE2000, DE4000, DE5000, DE6000
2 Applied to flooding from main rivers, raised reservoirs and coastal waters in England and Wales
3 Article 6.6 applied in DE4000, 5000 and DE6000, and Article 6.7 in DE2000.
4. The NL Authorities have stated that they have applied (though not reported to the Commission) Article 6.6 as low probability sea water flooding is only included in flood maps.

9. Compliance of the use of Article 13.2 with the requirements of Article 6

Member States may make use of maps finalised before 22 December 2010 as long as they provide a level of information equivalent to Article 6. Member States should have notified the Commission in their flood hazard and flood risk map reports to WISE whether they have applied Article 13.2 and may include a summary of additional relevant information to justify that the maps provided in accordance with Article 13.2 provide a level of information equivalent to the requirements of Article 6.

This Article was reported to have been applied in Germany and Slovakia. Luxembourg notified in the past the application of article 13.2, but did not indicate this explicitly in its 2014 reporting.

9.1 Germany

Article 13.2 has been applied in four UoMs in Germany (DE 2000, DE 4000, DE 5000, DE 6000); other Articles are also applied in these UoMs. There is no link between the specific areas to which the Article applies and the maps published. The reports in WISE state that the requirements of Article 6 have been applied in the preparation of maps: this has not been checked because of the reason above. However, it can be assumed that the information for these areas is the same as for those developed in accordance with Article 4 as each Land followed the same approach within its territory. This should be clarified with Germany.

In conclusion it is not clear from the reported information whether the use of Article 13.2 in the four UoMs in Germany provides a level of information equivalent to the requirements of Article 6.

9.2 Slovakia

Article 13.2 has been applied only in the Danube RBD (SK40000FD) for 29 specified Areas of Potential Significant Flood Risk; 355 APSFR have previously been reported for this UoM under Article 5. It was reported by SK in their reports to WISE that the use of Article 13.2 provided a level of information in flood hazard and flood risk maps equivalent to the requirements of Article 6. Links to maps of the APSFRs on the public viewer are identified by the local name: only APSFR codes were given in the WISE reports. Because of this, the presence of maps for the pertinent APSFRs could not be confirmed.

The SK Authorities subsequently stated that the web viewer had been updated to include a complete list of all APSFR specified by name of settlement, name of water course and code with the possibility to search and zoom in for all APSFR.

In general, maps for this UoM (which presumably includes maps for the specific APSFRs covered by Article 13.2) were prepared for five scenarios (Q5, Q10, Q50, Q100, Q1000), although the sources of flooding were not distinguished. The required hazard elements (extent, water depth or level, flow velocity) were included. Information on adverse consequences and impacts on local governance and public administration, emergency response, education, health and social work facilities (such as hospitals) are not explicitly provided in the maps even though this information was used within the methodology to determine, for each flood scenario, the type of economic activity affected. Information on property is not provided. Consequences on the status of water bodies and on cultural heritage were not mapped.

It would be expected that if the relevant APSFRs are shared with another Danube Member State, there would have been prior exchange of information on the preparation of flood hazard and flood risk maps under the auspices of the International Commission for the Protection of the Danube River (ICPDR) and relevant bilateral transboundary river commissions. There is no information on whether there are such shared APSFRs for which Article 13.2 has been applied.

The SK Authorities subsequently stated that the Slovak Republic had not identified APSFR with transboundary impacts.

In conclusion, it could not be confirmed from the available information that the maps for APSFRs covered by Article 13.2 fully meet the requirements of Article 6.

10. Preparation of flood hazard and flood risk maps in international UoMs

Article 6.2 requires that the preparation of flood hazard maps and flood risk maps for areas identified under Article 5 (Areas of Potential Significant Flood Risk) which are shared with other Member States should be subject to prior exchange of information between the Member States concerned.

For example, informal meetings for the purposes of exchanging information may have begun soon after the Floods Directive came into force, which may have resulted in the establishment of formal groups to ensure exchange of information and coordination as appropriate at both a technical and senior management level. Formal groups may have defined Terms of Reference and may have met on a number of occasions prior to the preparation of maps, discussing matters such as approaches to flood mapping in transboundary areas and the availability of suitable data. Representatives from the partner transboundary Member State may also participate in the relevant national groups responsible for producing the national maps. The production of the flood hazard and risk mapping for the shared flood risk areas may have involved the sharing and provision of detailed hydrology, topographical channel data, hydraulic river models, coastal model data, boundary condition data, digital terrain model (DTM) or digital elevation model (DEM) data, base map data and historic flood data. A joint technical working group may also have reviewed the mapping output to ensure the information is technically correct, consistent and meets the Floods Directive's requirements.

Member States sharing river basins that cross international borders must cooperate in their assessments of flood risk, coordinate their identification of Areas of Potential Significant Flood Risk in the shared basins and exchange information prior to the preparation of maps. There are 128 RBDs designated in the EU, of which 49 are international. If each national part of an international RBD is counted separately, the total number of RBDs is 170, of which 91 have an international component where the assessment of flood risk should be coordinated.

Often coordination is achieved through international river commissions, such as the International Commission for the Protection of the Danube River and the International Commission for the Protection of the Rhine.

Bilateral border commissions are also relatively common, providing a formalised mechanism for the two Member States to exchange information and coordinate plans to manage flood risk as well as other water management issues. Similarly, various international coordination and working groups have been established to carry out specific roles in flood risk management, including decision-making, the provision of advice (e.g. between Ireland and the UK), coordination of measures and the implementation of flood risk management measures (e.g. in the Danube).

Member States sharing river basins and Areas of Potential Significant Flood Risk should also exchange information with the relevant Member States prior to the preparation of flood maps. There seems to have been exchange of information in 15 of the 19 Member States that share river basins and have provided information for most, if not all, of their shared basins (Table 10.1).

International River Commissions play a significant role in this information exchange. For example, for Austria information was exchanged via the Danube, Rhine and Elbe River Commissions, for Belgium (Flanders) via the Scheldt and the Meuse River Commissions and for Germany via the Rhine, Elbe, Meuse and Danube River Commissions. In Lithuania the preparation of flood hazard and risk maps were extensively discussed in Lithuanian - Poland transboundary water commission meetings during 2012-2013. There has also been information exchange on methodologies and data with Latvia. The Toulouse Agreement provides the mechanism for the exchange of information in international UoMs shared between France, Andorra and Spain, and under the Albufeira Convention in the case of those UoMs shared between Portugal and Spain.

Information is exchanged between Ireland and the UK using the Floods Directive Cross Border Implementation Group and the Floods Directive Cross Border Technical Working Group. Data is shared and the mapping output reviewed to ensure it is consistent.

Table 10.1 Summary of the prior exchange of information on the preparation of flood maps between Member States sharing flood risk areas

MS	Number of national river basins shared with another Member State	Number where information was exchanged
AT	3	3
BE	7	6
BG	4	Not reported
CY	0	Not applicable
CZ	3	No information
DE	8	5
DK	1	Not clear
EE	1	Not applicable
EL(1)	5	1
ES (2)	6	6
FI	2	1
FR	4	No information
HR	2	Not clear
HU	1	1
IE (3)	3	2
IT	2	No information
LT	4	4
LU	1	1
LV	4	No information
MT	0	Not applicable
NL	4	4

MS	Number of national river basins shared with another Member State	Number where information was exchanged
PL	3	1
PT	6	No information
RO	11	4
SE	1	1
SI	2	No information
SK	2	Not applicable
UK	2	2

1 Based on one UoM (GR12)

2 The ES Authorities subsequently indicated that there are two RBDs, ES150 and ES160, shared with a non-EU Member States (Morocco), in which there has not been any exchange of information (nor has it been necessary).

3 The IE Authorities indicated that no shared APSFR with the UK had been identified in one (IEGBNISH – Shannon) of the 3 international UoMs shared with the UK

Not applicable means that the Member State concluded that there were no flood risk areas shared with a neighbouring Member State

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

Even though the impact of climate change on the occurrence of floods should, where possible, be taken into account in a preliminary flood risk assessment and in the subsequent reviews of the preliminary flood risk assessment and flood risk management plans, this is not a strict requirement of the Directive at the mapping stage. However, as Table 11.1 shows, 16 Member States have taken climate change into account when preparing their flood maps. For example, in Sweden the medium probability flood maps for river and lake flooding took account of predicted changes in climate to 2098. In Denmark, three future climate change scenarios were included in preparing medium probability maps for river and coastal flooding: for example, a 30 cm increase in sea level was considered.

Table 11.1 Summary of Member States who took climate change into account in their preparation of flood hazard and flood risk maps

	1	2	3	4	5	6
AT	Yes	Yes	Yes	Yes	Yes	Yes
BE	No	No	No	No	Yes	Yes
BG	Not reported					
CY	Yes	No	No	No	Yes	No
CZ	No	No	Yes	No	Yes	Yes
DE	Yes	No	No	No	Yes	Yes
DK	Yes	Yes	Yes	Yes	Yes	Yes
EE	No	No	No	No	No	No
EL[a]	No	No	No	No	No	No
ES	No	No	No	No	No	No
FI	Yes	Yes	Yes	Yes	Yes	Yes
FR	Yes	No	Yes	No	No	No
HR	No	No	No	No	Yes	Yes
HU	No	No	No	No	No	No
IE	Yes	No	No	No	No	No
IT	No	No	No	No	No	No
LT	Yes	Yes	Yes	No	No	Yes
LU	No	No	No	No	No	No
LV	No	No	No	No	No	No
MT	No	No	No	No	No	No
NL	No	No	No	No	Yes	Yes
PL	Yes	No	No	Yes	No	No
PT	No	No	No	No	No	No
RO	No	No	No	No	No	No
SE	Yes	Yes	Yes	Yes	Yes	Yes
SI	No	No	No	No	No	No
SK	Yes	No	Yes	No	Yes	Yes
UK	Yes	No	Yes	No	Yes	No

Key to columns

1	Climate change has been taken into account in preparing maps
2	Climate change trend scenarios have been obtained from international research programmes
3	Climate change trend scenarios have been obtained from the national research programmes
4	Flood hazard scenarios are based on modelling of changes in flood hazard in relation to climate change
5	Flood hazard scenarios included trend analysis of historical data of hydrological and meteorological observations
6	Flood hazard scenarios included a statistical assessment of historical climate data

a. Based on GR12 only

12. Conclusions

As of March 2015, 26 Member States had made available and provided information to the European Commission on their flood hazard and flood risk maps. Bulgaria had not yet reported any information and Greece provided information for only one Unit of Management. Both have informed the Commission that FHRM work is ongoing and will be concluded by end of 2015 and early 2016 respectively.

For eight Member States there are differences between the Areas of Potential Significant Flood Risk identified under Articles 5 and 13.1.a (due to be reported by March 2012) and those for which maps have subsequently been made available in 2014. It also appears that some sources of flood associated with Areas of Potential Significant Flood Risk have not been included in maps of the areas, though it may be the case that for some only the most significant source affecting the area has been mapped and/or all sources of flood associated with an area may have been combined in the map.

The most common source of flooding mapped by Member States is fluvial (25 Member States), followed by sea water (16 Member States), pluvial (13 Member States), floods from artificial water bearing infrastructure (7 Member States) and groundwater (3 Member States).

Most Member States mapping fluvial, pluvial or sea water floods expressed the medium probability flooding scenario as either a 100 year return period or 1% annual exceedance probability, as suggested by the Directive.

Most (23) Member States prepared fluvial flooding hazard maps with the required hazard elements for the appropriate flooding scenarios (for a list of the required hazard elements, refer to Section 4.1.2 of this report). Nine of the 13 Member States mapping pluvial floods showed the two required hazard elements for the two expected flooding scenarios. Eleven of the 16 Member States preparing sea water flood maps included the two required hazard elements for the two required probability scenarios.

The resolution of the spatial and elevation models used to prepare the maps in a number of Member States appears not to meet good practice examples: Italy, Belgium, Estonia and Latvia in terms of vertical resolution, and Latvia, Hungary and the Netherlands for spatial resolution. There was no information on these aspects for seven Member States.

The scale of some maps from a few Member States (Austria, Slovakia and Hungary) does not seem appropriate for informing and raising awareness of the public who may be concerned about flooding in their locality. In particular, the scale of 1:2,000,000 for maps in Hungary does not seem appropriate for use by the public.

22 of the 25 Member States for which there is information on their medium probability risk maps included the potential adverse consequences on human health, economic activity and the environment (including affected installations and effects on Protected Areas). Thirteen Member States reported potential adverse consequences on cultural heritage: 7 others have also included cultural heritage features on their national maps.

Germany and Poland applied Article 6.6 for sea water flooding in some of their Units of Management. The justification for the use of this Article was unclear in two Units of Management of Germany, whereas clear justification was provided by Poland even though they still prepared low probability maps as well as medium probability maps. Italy did not apply Article 6.6 but has only prepared low probability maps for sea water flooding, which is not in compliance with the Directive.

Germany, Hungary and the UK applied Article 6.7 for groundwater flooding and each provided justification for its use.

Of the six Member States applying Article 13.1.b, five (Belgium, Italy, the Netherlands, Portugal and Germany) may not have done so with complete accordance with the requirements of the Floods Directive.

It also could not be concluded that the use of Article 13.2 in some Units of Management in Germany and for some Areas of Potential Significant Flood Risk in Slovakia was in full compliance with the requirement of Article 6 of the Floods Directive.

There seems to have been an exchange of information in 11 of the 12 Member States sharing river basins for most, if not all, of their shared basins: the exception seems to be Lithuania. International River Commissions play a significant role in this information exchange.

Fourteen out of 27 Member States have taken climate change into account in the preparation of their flood maps.

13. Recommendations

There are several gaps in the availability of information on some Member States' flood maps. Bulgaria has not reported as of yet (expected by end 2015), Greece has only reported for one Unit of Management (full reporting expected by early 2016) and data from Croatia, Malta and Portugal had yet to be added to the WISE database when this assessment was undertaken. It is recommended that these information gaps are filled as soon as possible so that a complete EU overview can be obtained in the future, particularly with regards to the importance of mapping in the next step in the implementation of the Floods Directive, i.e. the preparation of flood risk management plans by 22 December 2015.

It is not clear from the selection of maps checked on national web pages or from the maps reported to WISE why some Areas of Potential Significant Flood Risk identified by Member States in 2011 under Article 5 or Article 13.1.a appear not to have been mapped. It is recommended that the Commission seeks clarification from the relevant Member States on this issue.

It appears that some sources of flood associated with APSFRs identified under Article 5 or Article 13.1.a have not been subsequently mapped. The reasons for this need to be clarified with the respective Member States.

A few Member States have produced maps at a scale that apparently does not meet best practice criteria for maps intended for public information and awareness raising. This should be confirmed with the relevant Member States and in particular whether smaller scale maps have been produced that may be more appropriate for public use.

The justification for the application of Article 6.6 in two Units of Management in Germany is not clear. This needs to be clarified with the Competent Authority. In addition, Italy only prepared low probability maps for sea water flooding but has not applied Article 6.6. This appears not to be in compliance with the Directive. Again clarification of this issue needs to be provided by the Competent Authority.

It is not clear whether the application of Article 13.1.b in Belgium, Italy, the Netherlands, Portugal and for some Units of Management in Germany is in full compliance with the requirements of Article 6. This issue needs to be raised with the respective Member States by the European Commission.

Twenty six Member States share river basins with another Member State. It is not clear from the available information as to whether there are shared flood hazard and flood risk areas within these shared basins. There is exchange of information in 11 Member States sharing flood risk areas but the situation with regards to the other 15 Member States in terms of the presence or not of shared flood risk areas and, if there are, as to whether there has been prior exchange of information on mapping, needs to be determined.

[The individual Member State Reports provide relevant background to the present Overview. For the individual MS Reports please check the dedicated files]

14. Annex 1 Overview of the application of the different Articles relating to the assessment of Flood Risk under the Floods Directive

MS	Article Applied	Units of Management	Source of Flood	All relevant sources [1]
AT	Article 4	AT1000, AT2000, AT5000		Yes
BE	Article 13.1(b)	BEEscaut_RW, BEEscaut_Schelde_BR, BEMeuse_RW, BEMaas_VL, BERhin_RW, BESchelde_VL, BESeine_RW		Yes
BG	Article 4	BG1000, BG2000, BG3000, BG4000		Yes
CY	Article 4	CY001		Yes
CZ	Article 4	CZ_1000, CZ_5000		Yes
DE	Article 4	DE1000, DE2000, DE3000, DE4000, DE5000, DE6000, DE7000, DE9500, DE9610, DE9650		Yes
DE	Article 13.1(a)	DE1000, DE2000, DE4000, DE5000, DE6000		Yes
DE	Article 13.1(b)	DE2000, DE4000, DE5000, DE6000		Yes
DE	Article 13.2	DE2000, DE4000, DE5000, DE6000		
DK	Article 4	DK1, DK2, DK3, DK4		Yes
EE	Article 4	EEEE1	Pluvial, Sea water	
EE	Article 4	EEEE2	Pluvial	
EL	Article 4	GR01	Fluvial	
EL	Article 4	GR02, GR13	Fluvial	
EL	Article 4	GR03, GR04, GR05		Yes
EL	Article 4	GR06	Fluvial	
EL	Article 4	GR07, GR08, GR11	Fluvial	
EL	Article 4	GR09	Artificial water-bearing infrastructure, Fluvial	
EL	Article 4	GR10	Artificial water-bearing infrastructure, Fluvial	
EL	Article 4	GR12	Fluvial	
EL	Article 4	GR14	Pluvial	
ES	Article 4	ES010, ES014, ES017, ES018, ES030, ES040, ES050, ES060, ES063, ES064, ES091, ES100, ES110, ES120, ES122, ES123, ES124, ES125, ES126, ES127, ES150, ES160		Yes
ES	Article 13.1(a)	ES020, ES070, ES080		Yes

MS	Article Applied	Units of Management	Source of Flood	All relevant sources [1]
FI	Article 4	FIVHA1, FIVHA2, FIVHA3, FIVHA4, FIVHA5, FIVHA6, FIVHA7	Artificial water-bearing infrastructure, Fluvial, Pluvial, Sea water	
FR	Article 4	FRFR	Artificial water-bearing infrastructure, Fluvial, Groundwater Pluvial, Sea water	
HR	Article 4	HRC, HRJ		Yes
HU	Article 4	HU1000	Fluvial, Groundwater, Pluvial	
IE	Article 4	GBNIIENB, GBNIIENW, IE07, IE08, IE09, IE10, IE11, IE12, IE13, IE14, IE15, IE16, IE17, IE18, IE19, IE20, IE21, IE22, IE29, IE30, IE31, IE32, IE33, IE34, IE35, IEGBNISH	Fluvial, Groundwater, Pluvial, Sea water	
IT (2)	Article 13.1(b)	ITI012, ITI01319, ITI014, ITI015, ITI017, ITI018, ITI021, ITI022, ITI023, ITI024, ITI025, ITI026, ITI027, ITI028, ITI029, ITN001, ITN002, ITN003, ITN004, ITN005, ITN006, ITN007, ITN008, ITN009, ITN010, ITN011, ITR051, ITR061, ITR071, ITR081, ITR091, ITR092, ITR093, ITR111, ITR121, ITR131, ITR141, ITR151, ITR152, ITR153, ITR154, , ITR161 I020, ITR171, ITR181I016, ITR191, ITR201, ITSNP01		Yes
LT	Article 4	LT1100, LT2300, LT3400, LT4500	Fluvial, Pluvial, Sea water, artificial water-bearing infrastructure	Yes
LU	Article 13.1(a)	LU RB_000		Yes
LV	Article 13.1(a)	LVDUBA, LVGUBA, LVLUBA, LVVUBA		Yes
MT	Article 4	MTMALTA		Yes
NL	Article 13.1(b)	NLEM, NLMS, NLRN, NLSC		Yes
PL	Article 4	PL2000, PL5000, PL6000, PL7000, PL8000, PL9000	Fluvial, Sea water	Yes
PT	Article 13.1(b)	PTRH1; PTRH2; PTRH3; PTRH4; PTRH5; PTRH6; PTRH7; PTRH8; PTRH9; PTRH10		Yes
RO	Article 4	RO1	Fluvial, Groundwater, Pluvial	
RO	Article 4	RO10	Artificial water-bearing infrastructure, Fluvial, Pluvial	
RO	Article 4	RO1000	Fluvial, Sea water	
RO	Article 4	RO11	Artificial water-bearing infrastructure, Fluvial, Pluvial	
RO	Article 4	RO2	Fluvial, Pluvial	

MS	Article Applied	Units of Management	Source of Flood	All relevant sources [1]
RO	Article 4	RO3	Artificial water-bearing infrastructure, Fluvial, Pluvial	
RO	Article 4	RO4	Artificial water-bearing infrastructure, Fluvial, Groundwater, Pluvial	
RO	Article 4	RO5	Artificial water-bearing infrastructure, Fluvial, Groundwater, Pluvial	
RO	Article 4	RO6	Pluvial, Sea water	
RO	Article 4	RO7	Fluvial, Groundwater, Pluvial	
RO	Article 4	RO8	Fluvial, Groundwater, Pluvial	
RO	Article 4	RO9	Artificial water-bearing infrastructure, Fluvial, Groundwater, Pluvial	
SE	Article 4	SE1, SE1TO, SE2, SE3, SE4, SE5		Yes
SI	Article 4	SI_RBD_1, SI_RBD_2		Yes
SK	Article 4	SK30000FD, SK40000FD		Yes
SK	Article 13.1.b	SK40000FD for 29 specific APSFR		
SK	Article 13.2	SK40000FD for 29 specific APSFR		
UK	Article 4	UK02_England, UK03, UK04, UK05, UK06, UK07, UK08, UK09, UK10, UK11, UK12	"Ordinary (minor) watercourses and all other sources of local flooding", Groundwater, Pluvial	
UK	Article 4	UKGBNIIENB, UKGBNIIENW, UKGBNINE	Fluvial, Pluvial	
UK	Article 4	UKGI17	Sea water	
UK	Article 4	UK01, UK02_Scotland		Yes
UK	Article 13.1(b)	UK02_England, UK03, UK04, UK05, UK06, UK07, UK08, UK09, UK10, UK11, UK12	"Main Rivers and large raised reservoirs", Sea water	

1 No specific flood types were reported and it is assumed that the Article is applied to all relevant flood types

2 The number of UoMs in Italy was reduced to 47 and reported officially to the European Commission on 16th April 2014.

15. Annex 2 Overview of the types of flood associated with Areas of Potential Significant Flood Risk identified under Article 5 of the Floods Directive

MS	Fluvial	Pluvial	Groundwater	Sea water	Artificial water bearing infrastructure	Other source
AT	2	1				
BE	Article 13.1.b applied					
BG	4	1		1	1	
CY	1	1				
CZ	3					
DE	10	1		7		
DK	1			2		
EE	2	2		1		
EL	14	6		8		1
ES	25	5	1	21		1
FI	6			2	1	
FR	14	5		10		
HR	2			1	2	
HU	1	1			1	
IE	25	1	1	25		
IT	Article 13.1.b applied					
LT	4			1		
LU		1				
LV	4			4		
MT	No APSFR reported					
NL	Article 13.1.b applied					
PL	3			2		
RO	12	12	2	2	9	
SE	6					
SI	2			1		
SK	2	2	1			
UK	5	12		5		

Note: the numbers in the cells are the number of UoMs within the Member States where the type of flood has been associated with APSFR identified under Article 5.

As reported to WISE up to August 2015

16. Annex 3 Summary of methodologies used to assess the potential adverse consequences to human health

MS	Summary of approach
AT	Up to 50 inhabitants; 51 – 500; 501 – 5000; above 5000. Official Austrian statistics listing all registered inhabitants per building. No differences regarding fluvial and pluvial flooding.
BE	For Brussels region: habitable area is the area of the housing, multiplied by the number of occupied floors. For Flanders: built-up area is calculated by municipality; the number of persons is calculated per m² built area for each municipality: 1-50; 50-250; > 250. For Wallonia: national register, number of inhabitants per address.
BG	Not reported
CY	The risk to human health has been determined using an estimation of the number of potentially impacted inhabitants. As there is no detailed information on "inhabitants per building" in CY, a process for estimating the affected inhabitants was followed using urban/spatial planning maps. The maximum number of potentially affected inhabitants was determined for each zone/area affected, based on the maximum square metres that can be constructed in each zone and assumptions on the area per person for different types of building (residential (18 m^2/person), offices (10m^2/person)) or land use (agriculture, 70 m^2/person).
CZ	A central register is used to determine the number of properties located within the flood extent. There is no information on the number of permanent residents therefore an average number of residents per property was used.
DE	The number of potentially affected population was determined by starting from a uniform distribution or a weighted distribution of the residents of a community on said surfaces and corresponding to the area covered by flood extents. In some UoMs, estimations of impacted inhabitants and buildings are based on the cadastral land register.
DK	The probability for loss of life due to flood is considered to be low, thus no estimates for loss of life were given. Only the number of potentially directly affected inhabitants is displayed in the maps. The number of inhabitants in a 100 m grid is derived by a cell-based risk assessment method, but no further details on data or calculation algorithms is provided.
EE	Census of population was geo-referenced based on the stated place of residence. The number of inhabitants affected shows the number of people registered as residing in the area affected by floods. The number of affected inhabitants is shown per entire APSFR.
EL	Based on the population density in each town and floodplains for settlements of medium size and larger (> 3,000). For small settlements the estimate of the percentage of the area of the settlement that could be flooded is not certain because of the relatively large size of the cell used in the hydraulic modelling: it has been considered that the total population is affected. Seawater floods do not affect residential areas.
ES	Population density from the EEA database was used: the overlap between the flooded areas and the population density maps determines the number of inhabitants potentially affected.
FI	The National Construction and Building Register was the source of information for determining the number of inhabitants in the APSFR: <10; 10-60; >60. The scale used is 1:20,000
FR	Determined by the intersection of a set of points with the flood surface based on the land database, gridded population database; population by municipality.
HR	Census data has been used with potentially exposed inhabitants expressed in 3 bands: less than 100, 100-1000 and more than 1,000.
HU	5 categories of the affected population: 0-2,000; 2,001-5,000; 5,001-30,000; 30,001-100,000 and 100,001-168,276 population range. Population statistics were used. If a settlement's boundaries only partially overlapped a given hazard area, then the total population was assigned to that hazard area. In Budapest, partitioning of the population was based on the percentage of the given district area within the given hazard area. The effects of tourism, daytime and night-time populations were not considered.
IE	Indicative number of inhabitants affected was calculated by multiplying the number of residential buildings by the number of residential delivery addresses per building, and by the average number of residents per residential property for the relevant area.

MS	Summary of approach
IT	Indicative number of inhabitants affected from Population Census at the cadastral level: it was assumed that, within each cadastral section, the population was evenly distributed. For some UoMs the differences in population densities were also taken into account.
LT	Population census spatial data: users can obtain exact number of inhabitants affected in a particular cell: a) large urban agglomerations - cell size 100 x100 m, b) urban agglomerations - cell size 250mx250m, c) other areas – cell size 1000 m x1000 m. The exact number is provided for cells where the number of inhabitants is 10 or more.
LU	Administrations of the 83 communities in the 15 APSFRs were asked to provide the number of inhabitants per street in relation to the areas of potential flooding for the 3 scenarios. Numbers represented in 4 categories: 1-50; 50-100 inhabitants; 100-500 inhabitants: >500 inhabitants at risk.
LV	The risk to human health was not calculated and visualised on the maps. The indicative density of inhabitants potentially affected in APSFRs is given as 15-30 people/km^2 and in other flood risk areas 5-10 people/km^2.
MT	Based on the data derived from the household municipal water billing database which contains information on the number of people living within each household unit. By combining the geographical location of the household addresses to the areas which were identified as having a significant flood risk, it was possible to quantify the number of inhabitants affected. In the quantification of the inhabitants affected, people living within multi-storey buildings were also included in the number of inhabitants that could potentially be affected.
NL	Risk on the number of inhabitants per 100 m^2: no details on how this was determined. High risk areas with primary protection measures (dikes) - which are common in the Netherlands - are converted to zero risk.
PL	Human health in terms of numbers of potentially affected inhabitants was not specifically presented on the checked maps. However, the numbers of potentially affected inhabitants has been reported (in the FHRM schema) with the detailed maps that will be visualised on the European scale maps. Elements that could affect human health e.g. waste management facilities, landfills, factories, are referred to in the legend. Address points were linked to the number of people registered in a specific building. The residential buildings and objects of particular social importance, for which the water depth is less than or equal to 2 m and the objects for which the water depth is greater than 2 m were presented. Objects of particular social importance shown on flood risk maps include hospitals, schools, nurseries, shopping centres, homes and social care facilities.
PT	Census data were used. Population density of constituencies (there are several in each municipality) were combined with the flooding area maps to estimate the number of population affected.
RO	National approach: The method took into consideration the following risk receptors: - the limit of each locality - the surface of each locality - the population of each locality - from the last census. This information was correlated and overlapped with the floodplains (for classes of depths previously established) in order to determine the affected population: (proportionally to flooded areas) at the level of each settlement, followed by aggregation at the APSFR level. In order to report under Flood Directive, for Danube flooding area, it was used the same methodology to assess the potential adverse consequences to human health as for all other UoM. Danube FloodRisk Project approach: affected population is computed at the NUTS 2 level (development regions of Romania) and include 4 classes: <10,000; 10,000-50,000; 50,000-100,000; >100,000 persons.
SE	For the maps only the night population is shown whereas in the accompanying tables the daytime population including the number of people working in the area of the flood extent is also shown. The data have been extracted from the public register and from the register of work places. Occasional inhabitants and tourists are not included, except in SE5 and one area in SE4. The counting of inhabitants has been undertaken for a 250 m^2 grid (or 1 km^2 grid for areas with low population density, e.g. SE2), including those grid units (squares) that are within or overlapping with the flood extent shown in the hazard maps for each of the scenarios. The population density has been divided into four classes that vary from place to place depending on the total population in the flood extent area. In the maps these classes are shown as "person" symbols where 1 person symbol is the class with the lowest range of population density (e.g. for Göteborg 1-50, or for Stockholm 1-100), 2 person symbols for the second class (e.g. 51-250 or 151-300), 3 persons for the third class (e.g. 251-500 or 301-800) and 4 persons for the highest range (e.g. 501-1200 or 801-1700). For the analysis the exact number of inhabitants, working population, etc. have been calculated by the Sweden Statistics, and are shown in the tables and are used in the FRMPs. Only fluvial floods were considered.
SI	Spatial data analyses of the central register of population and records of house numbers. Permanent and temporary inhabitants are considered. Scales: 1-50, 51-100, 101-500, 501-1000 and more than 1000 inhabitants per km^2.
SK	Indicative number of inhabitants potentially affected based on the ratio of the inundated and total area. It is presented on the map as the ratio of affected inhabitants to the total number of inhabitants in the basic residence unit.

MS	Summary of approach
UK	Scotland: counting properties located within the flood extent and multiplying by the average occupancy rate per household (2.2): 1 – 50, 51 to 500 and 501 – 1000. England and Wales: an average household size of 2.35 persons was used for residential properties, displayed on the maps as colour coded and size proportionate circles, for example, 0 – 1000 people at risk is shown as a small yellow circle, 5000 + is a larger red circle. Northern Ireland: the number of properties in the flood area was determined multiplied by 2.5 (average occupancy).

17. Annex 4 Summary of methodologies and economic aspects used to assess the potential adverse consequences to economic activity

MS	Summary of approach
AT	CORINE Land cover and national infrastructure data sets were used. Five categories shown on the maps: 1. living quarters; 2 industry and craft; 3 usages 'related to the settlement'; 4. agriculture, forestry and 'other grassland'; and 5. water bodies. The mapped infrastructures are: railway lines; railway stations; highways; hospitals and senior citizens' residences; schools and kindergartens; airports; and harbours.
BE	Brussels: number of potentially affected employees by municipality; industrial areas; roads; railways; metro; train or metro stations; covered parking space; private and public buildings. Flanders: land use maps to identify: water, residential area, industrial area, infrastructure, recreational area, cropland, meadows and nature area. Wallonia: the following aspects were considered: administrative services; school facilities; social and health services; police stations, fire brigade and civil protection; land occupied by shops, offices and services; industrial land; port areas; airports and airfields; campsites, residential parks and holiday villages; farm buildings and greenhouses.
CY	Based on the urban/spatial planning information available: residential areas, public areas (schools, stadia, etc.), commercial and other services areas, industrial areas, agricultural areas, and protected areas. There is no disaggregation according to types of economic activity.
CZ	Vulnerable areas derived from information on land use: residential area, civic amenities, technical infrastructure, transport infrastructure, production and storage areas, sport and recreation areas, forests and agricultural land.
DE	Different types of land use have been mapped (they are not always the same in all basins) covering at least: settlements and mixed use, industrial areas, transport, agriculture and forestry, "others".
DK	Flood loss functions are used for buildings and building contents, for agricultural crops and livestock, to derive monetary loss estimates. Further clean-up-costs per m^2 can be estimated. For infrastructure (e.g. roads and railway) only clean-up costs are considered, but not damages. In the web-GIS map viewer a layer can be displayed showing the value of buildings in a 100 m grid. Values range from below 5 million to more than 200 million Danish kroners. Background layers showing roads and railways can also be displayed.
EE	The Address Data System (ADS) containing information on buildings as it has been entered to the land register or register of building codes has been used. The buildings potentially affected by floods have been located according to the XY codes available in the ADS system.
EL	The risk of flooding is estimated from CORINE Land use data. The infrastructure that is vulnerable to flooding was determined utilising information gathered during the preparation of studies on the implementation of the WFD and in the Floods Directive preliminary flood risk assessment: national and major roads; railways; the main dykes on rivers; natural gas pipeline; irrigation pumping stations; drainage pumping stations; and water treatment plant locations. The depth of water is compared to existing embankments (flood defences) to assess whether or not they would be overwhelmed by the various flood events.
ES	National land use information was used.
FI	Infrastructure such as roads, energy grids, telecommunication networks, water supply and sewage facilities, vital community services. All these different elements are displayed on the map as point locations and explained in the legend. Economic activity is displayed on the flood maps in the land cover background map. When assessing the flood risk to properties, (e.g. rescue centres or hospitals), existing permanent and temporary flood protection structures, climate change, sewage flooding / basement floods etc. was taken into account. In addition the external impacts of floods, such as a cut in the electricity supply affecting hospitals, or a power plant's cooling system no longer being operational, were considered.
FR	The impact on the property is considered in the risk assessment if the number of permanent residents is greater than 0 in a potentially flooded area.
HR	The risk to economic activity is shown for the following: 1) Populated areas, agriculture, forests based on the CORINE Land Cover 2) Transport and energy infrastructure including airports, railway stations, river and sea ports, bus terminals, railways, highways and other roads, substations.

MS	Summary of approach
HU	Basis of risk maps is the CORINE Land Cover II map with 13 land cover categories. The following economic activities are indicated on the maps: - roads (motorways, main roads, secondary roads) - railway lines - built up areas (settlements) - harbours - airports.
IE	Determined by whether or not the activity is within the flood extent: no more detail reported. The types of economic activity included are: property, infrastructure, rural land use and economic activity. The national postal dataset is the basis for the property and economic activity assessment.
IT	All UoMs provide information on the source of information used to locate the economic activities on the map: the EEA CORINE Land Cover 2006 inventory, integrated with data from the different sectoral regional/local authorities according to the type of economic activities concerned. The economic activities considered and mapped were: continuous and discontinuous urban areas; economic activities (industrial, commercial and service areas; agricultural land (cropping systems, orchards, meadows, arable land, and vineyards), mining areas, wooded areas (shrubs, conifers and deciduous forests, and bushes); disused land in urban areas and waters and inland wetlands. Linear features mapped include roads and railways; point locations are related to public services such as schools, railway stations and hospitals.
LT	The risk to the types of economic activities in areas potentially at risk from flooding was calculated for 100 m x 100 m cells (1ha). The calculations were carried out using GIS data, and the depth data from the flood hazard maps. The assessment covers five impact groups: 1. Damage to buildings. The calculations are based on construction unit costs using depth/damage curves. 2. Damage to infrastructure. The calculations are based on the repair unit costs using depth/damage curves. 3. Damage to agricultural land. The calculations are based on the costs of lost production. 4. Damage to economic activities (manufacturing, constructions, services etc.). The calculations are based on the losses of GDP per person per working day. 5. Other economic damages. Calculated as a percentage of the damages listed above. The same approach was used for all the UoMs. Risk to economic activities is presented in colour coded grid cells on the maps. Using identification functionality of the map the users can obtain exact values for a particular cell.
LU	The CORINE Land Cover map was superimposed onto the flood hazard maps to determine the zones of economic activities in potentially flooded areas and the associated risks for the 3 scenarios was analysed visually. The land uses shown on the maps are as follows: (i) Urban, (ii) Agricultural, (iii) Woodland and semi-natural areas, (iv) Wetlands, (v) Lake/impoundment reservoir. No further details of the analysis are provided.
LV	The map layer with information on the risk to economic activity was not available for the assessment. The information reported to WISE indicates that the affected economic activities and the potential economic loss was evaluated using information from the municipal spatial planning documents for the land use in each municipality; the Cabinet of Ministers orders on compensations paid to floods affected municipalities and farmers; the Rural Support Service database data on use of agricultural land; interviews with representatives from various sectors (agriculture, transport, forestry, insurance, real estate). The value and damage of the objects that are subject to flooding were calculated with the assumption that the spring floods are in April and last up to 2 weeks. For each of the object categories key assumptions were defined that affect the amount of damage depending on the characteristics of the flood.
NL	Potentially flooded areas are divided into urban and rural areas with the latter categorised into 6 soil uses (6 colour schemes). The degrees of vulnerability related to economic values are not directly mentioned on the maps.
PL	Economic activities were defined by land use: residential areas; industrial areas; communication areas; forests; farmland: arable land, grassland; recreational areas; water; or other areas. Residential areas include: different types of properties and also infrastructure such as between e.g. blocks of flats such as playgrounds, parks, green spaces, courtyards, porches, buildings, livestock, land development, commercial, public administration. Industrial areas include: industrial and warehouse buildings, waste disposal areas. Communication areas include: roads, track, paved roads, airports. In addition, the buildings shown on the flood risk maps are assigned a specific function, which also shows the type of business activity. Industrial plants are divided according to the categories of activities such as energy, production and processing of metals, mineral, chemical, waste management and other activities. The information is visualised either using symbols or different colours, depending on the type of area.
PT	There was little information, though charts of soil use were said to be used.
RO	***National approach:*** The vulnerability of risk receptors was assessed taking into account the water depth and the potential damage on the flooded areas. The following risk receptors were considered: properties; infrastructure (airports, railway stations, ports); roads, railways, bridges, hydraulic structures (the minimum affected length criterion has only been used for roads, 200 m for main roads and 500 m for secondary roads); agricultural land (arable land, vineyards, orchards, secondary pastures, complex crop areas), and forests from CORINE Land Cover data; large industrial units specific to the Industrial Emissions Directive; small industrial units based on NAVTEQ data (the minimum affected number of such units has been used,

MS	Summary of approach
	being considered a minimum of 3 small industrial units in the flooding area). In order to elaborate flood risk maps, a risk matrix has been developed and applied, which takes into account various land use classes (based on Corine Land Cover and NAVTEQ data) and water depth. The risk was classified into insignificant, low, medium and high. ***Danube FloodRisk Project approach:*** Damage was calculated by applying damage functions for each category of the "goods" damaged. As a result, potential damages have been obtained, expressed as Euro / m^2 for different land use types and depths. Also, statistical calculations have been done again on direct and indirect damages. A function depth-damage represents the damage as a percentage of the total value of the specific land use, depending on depth.
SE	National guidance was used. Criteria used for mapping the risk to economic activity are the number of work places and day time population within the flood extent area of the flood hazard maps. Transport infrastructure of national importance is also included using the property maps (1:5,000 scale). The local authorities (municipalities) have been consulted to complete or correct the information. All relevant buildings of economic activity are included if they are within or overlapping with the flood extent area for each scenario. The consequences of floods for the economic activities have been assessed using both flow velocity and water depth to estimate accessibility and risk of damage. The risk for damage has been considered for properties (divided into industrial and other), for buildings (divided into buildings of societal importance and other), for transport infrastructure (roads, railroads, bridges, stations, airports and harbours, electricity and water supply), for forest and for agricultural land.
SI	The location of economic activity was analysed using CORINE Land Cover, as the national data layer of actual land use did not give separate categories for industrial, retail and transportation areas. To increase the accuracy, the number of businesses affected by floods, the national business registry and national registry of house numbers were also used. The national register of economic infrastructure was used to determine the risk on roads and railways. The risk to economic activity is visualised on the maps with five categories of land use (industrial, retail and transportation area, residential area, agricultural area, park area, water area) or as location of roads and railroads that are at risk. The public viewer gives the number of workplaces and businesses in a particular APSFR that are at risk because of flooding, as well as a number of kilometres of roads and railroads that are at risk in a particular APSFR. A table with numeric information is associated with each APSFR.
SK	The types of economic activities in the areas potentially affected by floods were determined from the available GIS databases. A wide variety of receptors was considered: administration, cultural, transport, industrial, energy, recreational, health. Risk is indicated on the map by areas of economic activities and by storage areas in the inundation area.
UK	A direct economic assessment of flood risk using a standardised depth/damage methodology was conducted for property in Scotland. The type of community service or utility is not displayed on the maps, only their location is identified. Length and type of roads impacted by flooding was calculated. Only roads located within flood waters above 0.15 m were displayed as driving becomes dangerous at this depth. Bridges were removed as including them would overestimate the impacted road lengths. The number and length of impacted railway lines were assessed. Airport terminals were identified. Direct damages to agricultural land were assessed using one-off cost values. The impact to agricultural land from pluvial flooding was not assessed as it is difficult to ascertain the impact of shallow and brief flooding on production/ loss of crops. In England and Wales airports, railways and roads were identified from the relevant datasets. Those properties affected by surface water flooding were also identified. Agricultural land was classified with the three best quality graded being included in the analysis. All of these activities can be viewed on the PDF maps. In Northern Ireland a direct economic assessment of flood risk was undertaken using a depth/damage methodology which gave a count of properties affected as well as damage figures for each of the probability flood events: this does not appear on the map viewer. Community services and utilities were identified and are displayed on the flood risk maps but this was not obvious.

18. Annex 5 Summary of methodologies used to assess the potential adverse consequences on industrial installations

MS	Summary of approach
AT	The risk to installations covered by the requirements of the Industrial Emissions Directive was determined on the basis of the European Pollutant Release and Transfer Register (E-PRTR) regarding IPPC/IED installations and urban waste water treatment (UWWT) installations >100,000 population equivalent (PE), which are covered on the risk maps under the common category 'Industry, waste /waste water disposal installation'. Additional sites (e.g. Seveso-sites, waste dumps, other point sources) can be added if necessary. Regarding abandoned hazardous sites, a priority system was developed, evaluating a) the priority assigned to the site (rating 1-3, 1 being of the highest risk), and b) whether a complete restoration has been carried out, or not (in the latter case, only safeguard measures are established, i.e. the site could be a potential source of pollutants in case of flooding). Depending on the combination of the two factors, it is decided whether an abandoned hazardous site is classified as 'significant' or not. Sites posing high or medium risk are classified as significant, and are depicted on the maps.
BE	For Brussels, IPPC installations are shown on the map when they lie in flood hazard areas. The flood scenario for each installation is not determined and any precautionary measures in place are not taken into account. Similarly in Flanders and Wallonia IPPC installations are mapped when they are in flood hazard areas. Also Seveso establishments and water treatment installations (2) are indicated on the map for Flanders. Landfill sites are also shown on the Wallonia maps.
CY	All IPPC installations were depicted on the relevant hazard maps. Such facilities include power plants, hazardous waste facilities, slaughterhouses, landfills, mineral products industries, large animal farms, etc. There was no specific focus on/selection of activities/installations with high pollution potential through the release of pollutants into water or land.
CZ	The number of affected IPPC installations was derived from the intersection of the flood extent maps with a GIS layer with the location of IPPC installations.
DE	The locations of IED plants have been considered. In those cases where this information was not available PRTR data and IPPC Directive installations have been used. One DE UoM considered plants that are within a 200 m buffer zone next to the flooded area. Plants close to a potentially flooded area have been assessed on a case by case basis in other DE UoMs.
DK	In the methodology description reported to WISE it is mentioned that no flood loss functions for critical infrastructure (IED-installations, police and fire department, health care facilities, etc.) exist so far. It is further mentioned that risk and IPPC-installations are shown in the map, but it was not possible to find such a layer in the national web map viewer.
EE	The maps visualise the installations covered by the requirements of the IED.
ES	Installations covered by the requirements of the Industrial Emissions Directive (IED) or previously under the IPPC Directive have been used from the corresponding National register. The information is displayed in pop-up boxes in the portals (national, regional and RBD) including some additional information e.g. on the name of the installation, its status, etc.
FI	The flood risk maps must display installations covered by the requirements of the Industrial Emissions Directive. Also other installations potentially causing environmental damage have to be shown including: fuel/chemical storage facilities; sewage/waste water treatment plants; waste treatment facilities; stables; and, fish farming facilities. Hazardous and explosive chemical production sites that, once flooded, could cause an immediate risk to human health and safety are also considered.
FR	The locations and the number of installations are obtained and mapped from the relevant national databases.
HR	The locations of the IPPC, IED and Seveso II installations are shown in the flood risk map. Also shown are the locations of other landfills and wastewater treatment works.
HU	The fluvial and groundwater hazard maps show four types of installations: Industrial Emissions Directive; IPPC; Seveso; and, the main waste water treatment works. Installations outside of the hazard areas are also shown on both maps.
IE	IED installations and IED facilities that were licensed in the past but are no longer licensed are both included within the relevant flood extent on the maps.

MS	Summary of approach
IT	IED installations have been acquired and integrated with other registered types of installations regulated by national/regional law, such as: Sites of National Interest, relevant accident risk industries and installations subject to the integrated environmental authorisation.
LT	All installations covered by Annex I of the IPPC Directive subject to flooding during the 10%, 1% and 0.1% flood events were mapped.
LU	Similar to the determination of zones of economic activities, the CORINE Land Cover map was superimposed on the hazard maps (all 3 scenarios) to determine the positions of IED installations, and their associated risks. Seveso installations are shown on the risk maps.
LV	IED installations are called “A class” polluting activity facilities / companies in Latvia. The information on all A class polluting activity facilities/companies is available on the Environment State Bureau website. Information about the location of these facilities was obtained from this source. The location of all A class polluting activity facilities/companies is indicated as a spot on a map. The construction of buildings and structures that are A class polluting activity facilities / companies is prohibited in the areas where there is a probability of flooding at least once in ten years.
NL	The IED facilities - complete with addresses - have been mapped out of a GIS-databank (National Institute for Public Health and the Environment (RIVM)-bases) on maps with the calculated water depths. There is no indication of vulnerability towards inundation. Both IED-data and the maps with calculated water depths are approximate, so the outcome must be regarded as indicative only.
PL	IED installations are presented on maps and are spilt by categories of activity in accordance with Annex 1 of the Directives. Industrial installations within the meaning of the Seveso Directive are also shown in the flood risk maps (lower-tier establishment and upper-tier establishment).
PT	Seveso and/or IPPC sites mapped.
RO	***National approach:*** Locations of IED/IPPC installations which might cause accidental pollution if any type of flood occurred are mapped. Other economic sectors potentially affected are included in the mapped risk layer obtained based on the risk matrix. ***Danube FloodRisk Project approach:*** The economic sectors potentially affected are shown on the Risk Map, where the legend of the map depicts three types of risk for Industry: Low, Medium and High, shown in three different shades of brown on the map.
SE	All IED/IPPC installations within or overlapping with the flood extent areas for each scenario and each area are included in the maps. No distinction has been reported as to whether the installations included in the risk maps have emissions to air or to water.
SI	IED/IPPC installations have been assessed according to their spatial distribution and size. To increase the level of accuracy, communal wastewater treatment works, communal dumping sites and companies liable to the Seveso directive were also assessed. There was no special focus on activities or installations with a high pollution potential through the release of pollutants into water or land rather than those that potentially only release pollutants into the air. All chosen industrial installations were treated equally and are visualised on the maps with specific symbols at the locations.
SK	The risk is presented on the map by indicating Seveso areas, storage areas, significant pollution sources and environmental loads. The number of affected installations was determined as the intersection of the installations geo-database and the inundation area.
UK	Scottish regulations segregate activities with a high pollution potential into Part A (release of pollutants into air, water or land) and Part B (release of pollutants into the air). The production of flood risk maps concentrates on authorised Part A sites only. The IPPC installation dataset is displayed as a series of point features and it is identified where they are located within a flood extent. In England and Wales active IPPC installations within the Environment Agency’s Pollution Inventory which fell within 50 m of the flood risk area are identified. In Northern Ireland, the production of flood risk maps considered Part A sites only. Each IPPC site is displayed as a polygon indicating the boundary of the installation. The occupant of the site is also recorded.

19. Annex 6 Summary of methodologies and approaches used to assess the potential adverse consequences on Protected Areas

MS	Summary of approach
AT	The Protected Areas at risk are depicted in the risk maps in three different ways/using three different symbols: Natura 2000 areas and Austrian National Parks are depicted as a single category; WFD Protected Areas are depicted as a single category (for better coordination with the implementation of the WFD), but not distinguishing between the type of protected area. The only exceptions to this are bathing waters, which are depicted with a point symbol on the risk maps independent of the location within or outside of a potentially flooded area.
BE	In Brussels the type of Protected Area is shown on the map but the risk is not determined for each scenario. Nature areas that overlap with the flood hazard map are indicated on the risk map. Several base maps have been used in Flanders including drinking water protection zones, recreational waters and Natura 2000 areas to identify where there is overlap with flood maps. In Wallonia there is only a summary of what areas are shown on the map.
CY	The only areas affected by potential significant flood risk areas are some of the Natura2000 Protected Areas which are shown on the different flood risk maps.
CZ	The number of affected WFD Protected Areas was derived from the intersection of the flood extent with GIS layers on WFD Protected Areas. The Protected Areas which can be affected only in marginal areas (areas in mountains) were excluded.
DE	Article 7 drinking water protection areas, bathing waters and Natura 2000 Protected Areas were considered. Not all maps have the type of Protected Areas listed in the legends.
DK	The methodology description mentions that groundwater interests including drinking water wells, as well as natural reserves / Protected Areas are shown on the same map as the IPCC installations. But it was not possible to find such a layer in the web-map viewer.
EE	The maps only partially visualise the WFD affected areas showing bathing water and Natura 2000 Protected Areas (different layers for habitat and birds).
EL	Protected areas (bathing water, Natura 2000, abstraction for drinking water, Birds and Habitats) with potential adverse consequences have been identified where there is overlap with flooding areas.
ES	Bathing Waters, Birds, Habitats, and WFD Article 7 drinking water Protected Areas have been retrieved from the GIS layers of the RBMPs, and physical overlaps with flood areas identified. Nitrates and UWWT Directive Protected Areas have not been considered. In ES010, flood risks for water-dependent species have been considered as positive, as they are thought to benefit these species. The information is displayed in pop-up boxes on the web maps' portals, except for the National map portal that only reports "yes/no" in a specific PDF fiche per APSFR. The ES authorities subsequently indicated that the problem with the national maps portal seems to be that most of the information displayed has not been found because of the difficulty of access.
FI	According to national regulations flood risk maps must display drinking water protection areas, bathing waters and Natura 2000 areas which are displayed as points on the map (with explanatory icons in the legend). The exposure of these areas is visualised on the map, however the impact of floods on the Protected Areas and the criteria used to assess the impact and risk to WFD areas is not clear.
FR	The impacted WFD Protected Areas are determined by the intersection of the WFD with the flooded area, determining for each impacted area the type (bathing, birds, habitats and groundwater wells) and the code.
HR	The protected areas considered in the flood risk are the Natura2000 areas, water protection areas, water intakes and bathing. Data is taken from the Register of Protected Areas.
HU	Separate maps for the risk to WFD Protected Areas were provided for fluvial and groundwater floods. Both maps have a scale of 1:2,000,000 and both indicate the following protected areas: - Natura 2000_SAC - Natura 2000_SPA - Ramsar - National parks, nature protection areas - groundwater protection zones. WFD Protected Areas outside of the hazard areas are also shown.
IE	Determined by whether any registered WFD Protected Areas are within the relevant flood extent. It has not been possible to determine the actual impacts until the Strategic Environmental Assessment, and assessments undertaken in relation to the Habitats and Birds Directives are completed.

MS	Summary of approach
IT	Protected Areas related to Habitat, Birds, Nitrates, UWWT, water intended for human consumption, bathing water, groundwater, surface water bodies as well as national and regional legislation have been identified on the maps. For each of these WFD Protected Areas, the level of risk attributable to each element has been identified by overlaying their surface area with the information available on the flood hazard maps. The potential impact of IED installations on Protected Areas was evaluated when: 1) the installation and the Protected Area are located within the area of flooding and, in turn, the installation is located within one or more Protected Areas; 2) the installation is not located within the Protected Area but in an area hydraulically connected to the flooded areas affecting the Protected Area.
LT	The flood risk map provides information on Bathing Waters, Birds, Habitats, Nitrates, UWWT Directive Protected Areas and WFD Article 7 Abstraction for drinking water Protected Areas subject to flooding for each of the three scenarios.
LU	The flood risk map legend lists the following Protected Areas: (i) Drinking Water Abstraction, (ii) Habitats Directive and (iii) Birds Directive.
LV	The Protected Areas considered were Natura 2000 sites, bathing waters, and nitrate vulnerable zones. The risk of flooding to surface water abstraction of drinking water was considered to be insignificant.
NL	The area and location of the WFD Protected Areas are indicated on the maps together with the flood probabilities.
PL	Article 7 drinking water Protection Areas, bathing waters and Natura 2000 were included on maps where relevant.
PT	RAMSAR sites were considered together with the Natura 2000 areas and sites.
RO	Article 7 abstraction areas for drinking water, bathing waters, national nature Protected Areas, natural monuments; Natura 2000 sites were taken into consideration when building the maps. However only their exposure has been shown as there are no associated damage-depth functions.
SE	A national method has been applied based on the WFD status reported in 2009 updated with the upcoming 2nd RBMP cycle status data to be completed in 2015. Potential flood impacts on the status class have been considered for water bodies within or immediately downstream of the flooded area. Protected Areas are included in the maps if they are within or overlapping with the flood extent for each of the scenarios. The following Protected Areas are included: Article 7 drinking water abstraction areas, bathing waters, Natura 2000 sites, nitrate vulnerable zones, sensitive areas under the UWWTD and shellfish production areas. Such areas are also included if they are located in, downstream and near the flooded area in the hazard maps.
SI	The risk to Protected Areas was assessed using spatial analyses of data layers of drinking water-protection areas, bathing waters, Natura 2000 sites, and natural heritage protected areas. The method that was used is simply to identify such areas within the flooding areas.
SK	Number of affected Protected Areas was determined as the intersection of the geodatabase of Protected Areas and the inundation area. The map shows where the Protected Areas overlap with inundation areas.
UK	A risk-based approach of identifying Protected Areas and bodies of water potentially affected by pollution from floodwater-inundated IPPC installations was undertaken in Scotland. This involved the implementation of active boundaries which consider travel and pollutant dispersal patterns where protected areas and bodies of water within these boundaries were highlighted as being potentially at risk. For fluvial floods, IPPC installations were considered to have an impact on Protected Areas and bodies of water downstream until pollutants reach the coastline. Environmental sites at risk are viewed on the map as shaded areas or as points for IPCC installations. In England and Wales bathing waters were identified if they were within 50 m of a flood risk area and other Protected Areas were identified by intersecting records with the hazard maps. These can be viewed on the map as circles with Special Areas of Conservation, etc. visible as shaded areas. In Northern Ireland it was not clear how Protected Areas are considered or shown on the maps.

20. Annex 7 Summary of methodologies used to assess the potential adverse consequences on cultural heritage and other potential receptors

MS	Summary of approaches
AT	Cultural heritage sites (UNESCO Cultural Heritage sites) are depicted as shaded areas when they are situated within a potentially flooded area. Other cultural assets, such as churches, theatres, museums and historical buildings, are not depicted, as there is no comprehensive information available on the federal level. Additionally, areas in which floods may carry a high amount of material/debris, i.e. alpine creeks with irregular course and heavy current, are marked on the maps by linear markings along the course of the water body.
BE	Protected buildings and archaeological sites located in the flood hazard zone are indicated on the risk map for Brussels. In Flanders no other consequences are considered. In Wallonia, architectural heritage, cultural heritage and the transport network are shown on the map.
CY	Water and waste water treatment works, and archaeological sites are depicted on the relevant maps.
CZ	The risk maps contain so called vulnerable objects. These include 1) objects with increased concentration of inhabitants with specific evacuation needs (schools, hospitals); 2) key infrastructure objects (electricity & gas distribution, drinking water supply); 3) significant pollution sources; 4) objects of the integrated rescue system; 5) cultural heritage sites/structures.
DE	Cultural heritage has been considered in all German UoMs and some other UoMs also considered other locally relevant information (e.g. water relevant infrastructure).
DK	An assessment for areas at risk from large amounts of sediments and floating refuse carrying pollution was undertaken, but no risk areas were identified.
EE	The maps do not visualise information related to cultural heritage, cultural assets, museums, spiritual sites and buildings.
ES	Mapping of cultural heritage is based on regional information sources, which is displayed in pop-up boxes in the national SNCZI viewer and in the regional viewers.
FI	Cultural heritage sites include libraries, archives, collections, and museums as well as art galleries, fixed antiquities such as archaeological sites; protected buildings; and World Heritage Sites.
FR	There is no mention in the WISE reports that cultural heritage was taken into account but the screening of the maps shows that impacted cultural heritage is shown for 5 UoMs.
HR	The risk to hospitals, schools, kindergartens, retirement homes and cultural heritage (UNESCO) is also taken into account in the Risk Maps.
HU	No such kind of risk map was provided by Hungary.
IE	Flood maps are being developed that include: Flood Zones, areas prone to flooding in the event of failure of certain flood defences, the density of economic flood risk, the location of highly vulnerable sites, social amenity sites and social infrastructural assets potentially prone to flooding and the location of cultural heritage sites potentially prone to flooding.
IT	Landscape, archaeological and cultural heritage sites were considered where appropriate. Additional information considered relevant relates to the areas of debris flows. For this type of phenomenon, given that systematic observations over long periods and therefore data to evaluate the return period are not available, only the mapping of the areas potentially affected by debris flows was carried out.
LT	The flood risk map provides information on cultural heritage sites, urban waste water treatment plants, waste management utilities, schools, hospitals, police offices, etc.
LU	Historic discharges and polluted sites, as well as 'sensitive buildings', such as schools, hospitals and other care institutions were also indicated on the risk maps.
LV	No other information was considered at this stage.
NL	No other consequences were included.

MS	Summary of approaches
PL	Areas and objects of cultural heritage, including areas and historical buildings, in particular those covered by the UNESCO World Heritage regulations, open-air museums and museums listed in the National Register of Museums, libraries with collections of the national library resources and national archives were included on the risk maps where relevant. Potential pollution from flooded sewage treatment works, pumping stations, landfills and cemeteries was also considered.
PT	Other consequences considered were sites with historical interest and heritage classified at national or global level.
RO	Potential adverse consequences on churches, monuments, museums.
SE	Cultural Assets have been considered, such as archaeological sites / monuments, architectural sites, museums, spiritual sites and buildings; Landscape and other cultural heritage. Through a dialogue with the local authorities (municipal level) a number of other issues has been included in the flood risk maps, such as buildings of societal importance (schools, hospitals, emergency service call centres, fire stations, police stations, water works etc.). For SE3 and SE4 there are also many polluted areas, other than those classified as risk class 1, that could impact the flooded areas. Due to the large number of such areas, they are not shown on the maps, but will be considered in the flood risk management plans. For SE5 areas prone to erosion and landslides have also been considered, but not included, due to the lack of a unified method to show these areas on maps.
SI	The potential risk to sensitive buildings is also considered, for example: where evacuation can be difficult (schools, kindergartens, hospitals, health centres, homes of elderly people and health resorts); where exceptional material, cultural or social damage can occur (libraries, museums, archives); where damages can cause large indirect economic loss (transport, supply); location of emergency services (fire fighting, rescue and police station); public utility water treatment plant and public utility dumps as potential sources of water pollution.
SK	Number of affected installations which might cause accidental pollution in case of flooding was determined as the intersection of the geo-database of these installations and the inundation area.
UK	In England and Wales World Heritage Sites, Parks and Gardens of Special Historic Interest, Scheduled Ancient Monuments (SAMs) and Listed Buildings were considered to be relevant and mapped.

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