Update on the identification of potential significant flood risk areas in the international river basin district Rhine

Third cycle of the FD - December 2024

International Commission for the Protection of the Rhine

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Publisher:
International Commission for the Protection of the Rhine (ICPR)
Kaiserin-Augusta-Anlagen 15, D-56068 Koblenz
P. O. box: 20 02 53, D-56002 Koblenz
Telephone: +49-(0)261-94252-0
E-mail: sekretariat@iksr.de
www.iksr.org

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Foreword

On 18 October 2007, the Conference of Rhine Ministers commissioned the International Commission for the Protection of the Rhine (ICPR) to take over the necessary coordination and consultation between the EU Member States at the level of the International River Basin District Rhine (IRBD Rhine), including Switzerland, for the implementation of "Directive 2007/60/EC[1] of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks" (hereinafter referred to as "FD"), as was the case for the Water Framework Directive (WFD).

Switzerland and Liechtenstein are not members of the EU and are therefore not obliged to implement the FD. As with the implementation of the WFD, Switzerland and Liechtenstein have supported the EU Member States in coordinating the implementation of the FD on the basis of their national legislation.

The EU Member States are in charge of reporting on the state of implementation of the FD to the EU Commission.

According to FD Article 4 the **EU member states** proceeded to a **preliminary flood risk assessment (PFRA)** for the first cycle by 22 December 2011. According to FD Article 5, EU Member States were required to **identify areas presenting a potential significant flood risk (APSFR)**. The preliminary flood risk assessment according to FD Article 4 and the identification of potential significant flood risk areas according to FD Article 5 jointly coordinated at the level of the IRBD Rhine are part of a first and second report[2] (updated in accordance with FD Article 14) of the EU Member States in the IRBD Rhine.

In accordance with FD Article 14[3], the expected effects of climate change on the occurrence of floods were taken into account from the second cycle onwards (2018 report). After 2018, i.e. still within the 2nd cycle of the FD, the national Flood Hazard Maps (FHM) and Flood Risk Maps (FRMP) and the associated report of the IRBD Rhine[4] , the ICPR Rhine Atlas[5] and the International Flood Risk Management Plan (IFRMP)[6] were updated.

As part of the PFRA and APSFR, which are to be reviewed every six years and updated if necessary, the ICPR (Working Group "Flood and Low Water") has **updated the 2018 report on the basis of the new information (present version).**

[1] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32007L0060
[2] https://www.iksr.org/en/eu-directives/floods-directive/flood-risk-assessment
[3] The recommendations of the EU guidelines "River basin management in a changing climate" updated in 2024 (Chapter 6 "Flood Risk Management and Adaptation", p. 71 ff) on how climate change can best be taken into account in the implementation of the FD were reviewed and followed up as part of this report.
[4] https://www.iksr.org/fileadmin/user_upload/DKDM/Dokumente/BWP-HWRMP/EN/bwp_En_2d_FDreport_Upd.2019.pdf
[5] https://www.iksr.org/en/public-relations/documents/archive/maps/rhine-atlas
[6] https://www.iksr.org/fileadmin/user_upload/DKDM/Dokumente/BWP-HWRMP/EN/bwp_En_2d_IFRMP_2021.pdf

Indeed, there have been some notable developments in the field of flood management in the IRBD Rhine in recent times: At the 16th Rhine Ministerial Conference in Amsterdam on 13 February 2020, the ministers and the representative of the European Commission on behalf of the EU adopted the "Rhine 2040" programme entitled "The Rhine and its catchment: sustainably managed and climate resilient". The programme corresponds to a voluntary commitment by the states and represents the ICPR's working basis for the next 20 years, i.e. in the medium/long term, including for flood risk management up to 2040. Rhine 2040 aims to reduce flood risks on the Rhine and its tributaries by at least 15 % by 2040 compared to 2020. This is to be achieved through a combination of measures that are supported by all participating countries. There are 7 specific goals and 16 accompanying measures to achieve this general objective. Objectives and measures have also been set in the area of climate change adaptation, with the corresponding ICPR strategy to be updated by the end of 2025. One of the most important foundations of the "Rhine 2040" programme is the assessment of the "Rhine 2020" programme, including the Action Plan on Floods (APF) for the period 1995-2020.

For a general and detailed description of the IRBD Rhine with maps on the boundaries of the catchment area, the sub-catchment areas, the coastal areas as well as the topography and land use, please refer to the International River Basin Management Plan of the IRBD Rhine[7] according to WFD. For further details on flood risk management, please refer to the International Flood Risk Management Plan (IFRMP) of the IRBD Rhine according to the FD[8].

Special note on this report and the reporting of the EU states of the Rhine basin to the EU:

The reporting of the EU member states to the EU Commission followed the provisions of the "Guidance for Reporting under the Floods Directive (2007/60/EC)[9]" (2013).

The report at hand and the jointly drafted survey map in Chapter 3.2 serves the EU states

(1) as a documentation for applying FD Article 4 (preliminary flood risk assessment) and FD Article 14 in the IRBD Rhine (part A, catchment > 2,500 km²)

(2) as a proof for the exchange of information required according to FD Article 4, Par. 3

(3) as a proof for the coordination in the IRBD Rhine required according to FD Article 5, Par. 2 or in management units (sub-basins) shared with other member states and covered by the reporting obligation.

[7] https://www.iksr.org/en/eu-directives/european-water-framework-directive

[8] https://www.iksr.org/en/floods-directive/flood-risk-management-plan/

[9] See Guidance Doc. No. 29 "A compilation of reporting sheets adopted by WD CIS for the WFD (2000/60/EC)", Technical Report - 071", 2013.

General link: https://environment.ec.europa.eu/topics/water/floods_en

1. Historical flood events, potential future significant adverse consequences and impacts of climate change

1.1 Types of floods

The flood risk assessment jointly coordinated in the IRBD Rhine focusses **on floods or fluvial floods.** This also includes **lake inundation**. However, coastal floods on the Dutch coast and localised flooding from groundwater, heavy rainfall, pluvial floods, certain types of flash floods (which normally fall into the category of fluvial floods) and localised mud floods can also cause very extensive damage.

As part of the coordinated implementation of the FD, in particular for the calculations of the flood hazard maps or for the IFRMP, the states agree on the discharge values for the three flood scenarios along the Rhine and update them if necessary (see values in Annex 2).

In recent years, the countries of the Rhine basin have been working intensively on reducing the risks posed by heavy rainfall, pluvial flooding and flash floods and have undertaken numerous activities in this regard. The importance of working to reduce these types of risks, which can affect the entire Rhine basin, was sadly reminded by the heavy rainfall and flooding in July 2021. This topic is also reflected in the "Rhine 2040" programme and its integration into the work of the ICPR was discussed at an ICPR workshop in October 2023[10] . The ICPR workshop planned for mid-2025 to prepare the update of its climate change adaptation strategy will also deal with this topic.
Many countries include these risks (heavy rainfall, pluvial flooding and flash floods) in their identification of potentially significant flood risk areas. This report therefore contains new information on these risks in Chapters 2 and 3.

The coastal area of the Rhine catchment is entirely located within the frontiers of the Netherlands and the influence of marine water levels including a rise of the sea level on the Rhine is limited to the Netherlands. Therefore, this report does not take into account coastal floods.

Sources of flooding other than fluvial floods are described in the national preliminary flood risk assessment reports. A summary of the consideration of flood types at national level can be found in Chapter 2.1 and the links in Chapter 3.3 as well as Annex 3.

[10] https://www.iksr.org/en/public-relations/events/workshop-heavy-rain-and-flash-floods and **results report**

1.2 Flood generation

In the Rhine catchment, different discharge regimes (see Fig. 1) with different flood characteristics overlap one another.

- The Alpine and High Rhine (gauge Basel) with glacial-nival regime components of the high mountain range (floods mainly during the summer);
- Waters draining the Central Upland region (Neckar, Main, Nahe, Lahn, Moselle, etc.; Trier gauging station) are characterised by a pluvial runoff (dominated by winter floods);
- As these two regimes overlap, the downstream discharge distribution over the year ("combined regime", Cologne gauging station) is increasingly uniform (dominated by spring and winter floods).

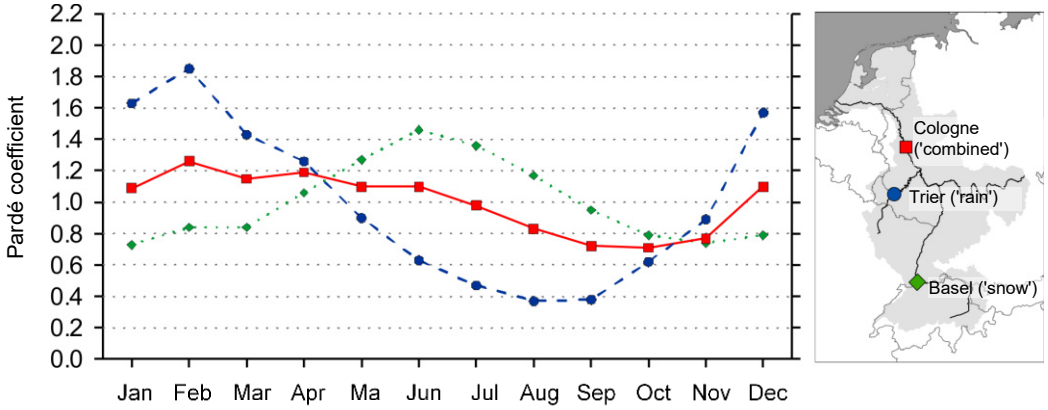


Figure 1: Typical discharge regime in the Rhine catchment according to Pardé[11] ; reference period 1961-1990

Furthermore and due to watercourse realignments/regulation since the 19th century until way into the 20th century (1977) (among others regulation of the Alpine Rhine, correction of water courses in the Jura, training of the Upper Rhine, weir-regulated tributaries), floods are also influenced by man. Depending on the river section concerned, this may lead to increased flood protection or downstream of trained sections and due to less alluvial areas and a shorter water course (speeding up of waves) this may lead to increased flood risk.

In addition to these seasonal flood events, local or regional heavy rainfall events can also occur in the entire Rhine basin, which can lead to short-term flooding in small and medium-sized water bodies (pluvial floods, flash floods).

Finally, the latest results on climate change impacts on the above-mentioned discharge regimes (ICPR, 2024[12]) show a general tendency towards more rain-fed discharge regimes to the detriment of snow- or glacier-fed discharge regimes in the Rhine basin. As a result, summer flows decrease and winter flows increase, whereby the mean annual flow remains almost unchanged (see further details on climate change effects in Chapter 1.6).

As a consequence of climate change, it is generally expected that in the future winter flows will increase and summer flows will decrease. The hydrological regime will be characterised by discharge resulting more from rainfall than from melting snow and glaciers.

[11] Pardé coefficient = ratio of multi-year monthly runoff to multi-year annual runoff.

[12] https://www.iksr.org/en/public-relations/documents/archive/technical-reports/reports-and-brochures-individual-presentation/297-climate-change-induced-discharge-scenarios-for-the-rhine-basin

1.3 Historical flood events

If floods occur in several sub-catchments and/or river sections, exceptional events may occur over a wide area in the Rhine. The table below (ICPR, 2012)[13] contains a representative selection of historical/past Rhine floods between 1882 and 2003 with different genesis and different regional significance. Significant flood events also occurred on the Rhine or on certain sections of the Rhine after 2003[14][15] such as in August 2005 ("Alpine flood 2005", affected areas: Switzerland, Austria, southern Bavaria, the Black Forest and parts of North Rhine-Westphalia), August 2007 (Switzerland), end of May/beginning of June 2013 (larger section of the Rhine) or July 2021. Historical flood events on the Alpine Rhine and Lake Constance are also mentioned separately due to their different characteristics: 1817, 1888, 1927, 1954, 1987, 1999 and 2005[16]. Coastal floods on the Dutch coast are described in Dutch national reports.

Table 1: Representative historical floods of the Rhine at the different gauges with flood peak discharges and probabilities (ICPR, 2012)

Discharge probabilities *(Status 1977, without retention measures)*	Gauge **Basel** [m³/s]	Gauge **Maxau** [m³/s]	Gauge **Worms** [m³/s]	Gauge **Mainz** [m³/s]	Gauge **Kaub** [m³/s]	Gauge **Andernach** [m³/s]	Gauge **Cologne** [m³/s]	Gauge **Lobith** [m³/s]
HQ_{10}	*3980*	*4100*	*4750*	*5700*	*5800*	*8850*	*9010*	*9459*
HQ_{100}	*4780*	*5300*	*6300*	*7900*	*8000*	*12200*	*12000*	*12675*
$HQ_{extreme}$	*5480*	*6500*	*7600*	*10300*	*10400*	*15250*	*15300*	*16000*
Discharge peaks								
Flood 1882/ 1883[b]	4100	6260	7520	9668	9653	12470	12886	10690[a]
Flood 1918/ 1919	3850	4480	4710	5163	5047	6680	6748	6896
Flood 1919/ 1920[b]	3,160	4520	5380	7235	7365	10849	10951	11394
Floods 1925/ 1926[c]	2150	3260	4234	5923	5992	10394	11021	11694
Flood 01 1955[b]	3240	4560	6160	6836	6832	10340	10324	10328
Flood 02 1957	3340	4140	4590	5606	5634	7530	7580	7807
Flood 02/ 03 1970[b]	3190	4200	4990	4823	7105	9340	10137	10780
Flood 05 1978	3000	4180	5270	5800	5857	6339	6401	6656
Flood 02 1980[b]	3370	4160	4763	5939	6010	8666	9084	9630
Flood 04 1983[b]	2249	4110	4990	6178	6318	9736	9888	9817
Flood 05 1983[b]	3078	4260	5250	5967	6227	9768	9953	10043
Flood 03 1988[b]	3273	4090	5270	7161	7240	10029	10022	10852
Flood 12 1993	2109	3020	4765	5567	6493	10600	10800	11039
Flood 01 1995[b]	3485	4080	4245	5935	6670	10200	10940	11885
Flood 10 1998	2818	3320	3675	4881	5454	8360	8989	9487
Flood 02 1999	3833	4490	4945	5597	6022	7778	8082	7974
Flood 05 1999[d]	5085	4720	4577	4455	4662	4643	4671	4516
Flood 01 2003	2036	2810	3522	5060	5540	8722	9329	9451

a: Discharge reduction between the gauges Cologne and Lobith, presumably due to the flooding of dikes
b: Continuous extreme floods (classification according to Schwandt & Hübner 2009 in UNDINE, BfG 2018)
c: Extreme floods in river stretches (classification according to Schwandt & Hübner 2009 in UNDINE, BfG 2018)
d: Additional discharge value for the Basel gauge (FOEN, 2018) The differences compared to discharge values downstream are explained by the flood generation (flood events 1999 on the High Rhine and the Upper Rhine), limited inflows from the Black Forest and R. Neckar, the use of retention areas and natural retention in the river and the flooded foreshores (information given by the ICPR Expert Group HVAL, 2018).

[13] List and information according to studies of the ICPR Expert Group HVAL, see: https://www.iksr.org/fileadmin/user_upload/DKDM/Dokumente/Fachberichte/DE/rp_De_0199.pdf (EN information here)

[14] However, for methodological reasons these are not included in the ICPR's EG HVAL studies.

[15] Sources :

2005: https://de.wikipedia.org/wiki/Alpenhochwasser_2005, https://en.wikipedia.org/wiki/2005_European_floods, CH: https://www.bafu.admin.ch/bafu/de/home/themen/naturgefahren/publikationen-studien/publikationen/ereignisanalyse-hochwasser-2005-analyse-von-prozessen-massnahmen-und-gefahrengrundlagen.html, AT: https://info.bml.gv.at/dam/jcr:2c213262-9b0e-40db-a73a-ab5e333c38ad/Bericht_Hochwasser_August2005.pdf;

2007: https://de.wikipedia.org/wiki/Hochwasser_in_der_Schweiz_2007

2013: https://de.wikipedia.org/wiki/Hochwasser_in_Mitteleuropa_2013, https://en.wikipedia.org/wiki/2013_European_floods https://www.eskp.de/naturgefahren/das-juni-hochwasser-2013-in-deutschland-935306/

2021: https://www.bafu.admin.ch/bafu/de/home/themen/wasser/dossiers/hochwasser-juli-2021-intensive-niederschlaege-fuehrten-verbreitet-zu-ueberschwemmungen.html

[16] Sources: http://alpenrhein.net/; https://www.planat.ch/en/; https://de.wikipedia.org/wiki/Alpenrhein

In addition, the following table shows historical floods on selected Rhine tributaries in a simplified form[17].

Table 2: Representative historical flood events on Rhine tributaries

Selected flood events in tributaries of the Rhine *(PFRA Rhine basin 2011, BfG Undine, PLANAT, Wikipedia, 2018; national DE/CH information and Wikipedia, 2024)*				
Aare	**Moselle**	**Main**	**Neckar**	**Ahr**
1480	February/March 1784	July 1342	February/March 1784	1601
1651	October 1824	January 1682	October/November 1824	1804
1852	February/March 1844	January 1764	December 1882 / January 1883	1910
1876	March/April 1845	February/March 1784	December 1919	2021
1999	January/February 1850	March/April 1845	Mai 1931	
2005	November/December 1882	February 1862	December 1947 / January 1948	
2007	December 1919 / January 1920	February 1876	February/March 1956	
2021	December 1925 / January 1926	November/December 1882 / January 1883	February 1970	
	December 1947 / January 1948	February 1909	December 1993	
	January 1955	January 1920		
	April/Mai 1983	December 1947 / January 1948		
	December 1993	February 1970		
	January/February 1995	March 1988		
		January/February 1995		
		January 2003		

1.4. Concrete examples for adverse effects and damages

Autumn and winter flood 1882/83

The flood caused catastrophic damages (dike breaches, deterioration of traffic ways, damage to buildings, damage to crops, soil erosion, sand coverage, loss of supplies, ...) in big cities as in smaller places along the Rhine and its tributaries. The number of casualties is not known. In order to repair the damages, authorities as well as private donors had to partly provide considerable financial aid. (Source: UNDINE)

Winter flood 1925/26

There were no considerable damages in the southern Rhine catchment including R. Main. Downstream, a considerable share of the total damages was in particular due to building damages (e.g. in Cologne with 72,000 persons concerned) and to damages in agriculture (loss of field crops and crop supplies, soil erosion, sand coverage, ...). Hydro-engineering installations were damaged. There were no reports of flood victims. (Source: UNDINE)

Winter flood 1993 and 1995

The big flood events in 1993 and 1995 developed from high inflows into the Rhine downstream of Koblenz, in particular from the Moselle area and caused considerable damage on the Lower Rhine (1993: approx. 511 million euros and 1995: approx. 281 million euros)[18]. In the beginning of February 1995, feared dike breaches caused the evacuation of some 250,000 Persons in the Rhine delta. In May 1999, there was another major flood event on the High and Upper Rhine. (Sources: UNDINE, 2nd IFRMP of the IRBD Rhine[19])

Flooding and heavy rainfall in July 2021

In July 2021, a large, relatively stationary low-pressure system caused heavy rainfall events, pluvial flooding and flash floods, particularly in the Dutch province of Limburg, Wallonia (Belgium), North Rhine-Westphalia and Rhineland-Palatinate. Luxembourg and parts of Baden-Württemberg, Bavaria, Austria and Switzerland were also affected. The floods in the Rhine and Meuse basins claimed 220 lives (188 people in Germany alone, as at June 2023[20]). The total amount of residential and transport infrastructure damaged by

[17] Sources: http://undine.bafg.de/rhein/extremereignisse/rhein_extremereignisse.html; EPRI Bassin du Rhin 2011; https://www.planat.ch/en/; https://en.wikipedia.org/wiki/Aare

[18] Sources: http://undine.bafg.de/rhein/extremereignisse/rhein_hw1993.html, http://undine.bafg.de/rhein/extremereignisse/rhein_hw1995.html

[19] https://www.iksr.org/fileadmin/user_upload/DKDM/Dokumente/BWP-HWRMP/EN/bwp_En_2d_IFRMP_2021.pdf

[20] Sources: https://de.wikipedia.org/wiki/Hochwasser_in_West-_und_Mitteleuropa_2021, https://en.wikipedia.org/wiki/2021_European_floods

heavy rainfall and flooding reaches more than 46 billion euros, with Germany accounting for more than 33 billion euros. (Sources: 2nd IFRMP of the IRBD Rhine[21] and others[22])

1.5 Potentially significant detrimental consequences

ICPR calculations in 2021 concerning the four assets (objects) according to the FD based on information taken from the national flood risk maps in the ICPR Rhine Atlas 2020, summarise the following theoretical damages resp. potentially significant adverse consequences:

- **Human health**: some 66,630 people live in flood prone areas along the Rhine with a high probability of floods, some 2 million live in areas with a medium flood probability and some 5.2 million in areas with low flood probability (i.e. extreme floods).
- **Cultural heritage:** The number of cultural assets potentially affected by extreme flooding on the Rhine is approx. 4,612.
- **Environment:** On the Rhine, there are a total of approx. 2,095 IPPC/IED or SEVESO sites potentially affected by flooding. In the extreme floodplain, there are 480 bird protection areas (approx. 129,065 ha), 488 flora-fauna-habitat areas (approx. 79,911 ha) and 728 water protection areas (approx. 715,776 ha) (RBMP 2015/Rhine Atlas 2020), which normally benefit from flooding but may suffer detrimental consequences if polluted.
- **Economic activities:** The potential economic damages, calculated on the basis of different types of land use (Corine Land Cover 2018) and damage functions related to water level and taking into account flood risk management measures[1] carried out amount to an order of magnitude of approx. 54 billion euros for an extreme event on the entire main stream of the Rhine (without the effect of measures, potential damage amounts to approx. 76 billion euros).

1.6. Consideration of the likely impact of climate change on the occurrence of floods

According to FD Article 14, Par. 4, the reviews and updates of the preliminary flood risk assessment, the flood risk areas and the FRMP (FD Article 14, Par. 1 and 3) shall take into account the likely impact of climate change on the occurrence of floods. Similar to the update of the report on the risk areas[23] in 2018, this chapter looks at how climate change has been taken into account at the level of the IRBD Rhine but also at the level of the states in the Rhine catchment. The national reports and methods (see Chapter 3.3) go into more detail on the consideration of climate change.

In 2015, the ICPR published the Climate Change Adaptation Strategy for the IRBD Rhine (see ICPR Technical Report No. 219) on the basis of climate scenarios and projections from a 2011 ICPR study (see ICPR Technical Report No. 188)[24] . To this end, the ICPR states have agreed on possible fields of action within flood prevention. As part of the "Rhine 2040" programme, the discharge projections (climate scenarios) for 2050 and 2100 were updated in 2024 (see ICPR Technical Report No. 297)[25] . Resilience to climate change via a regular update of the ICPR climate change knowledge and adaptation strategy (soon until the end of 2025) is the focus of "Rhine 2040". It should also be noted that the Commission for the Hydrology of the Rhine Basin (CHR) is dealing extensively with the effects of climate change on the discharge regime of the Rhine, particularly in the context of the published studies ASG I and II[26] and the planned "Rheinblick2027" programme (results are expected by the end of 2027).

[21] https://www.iksr.org/fileadmin/user_upload/DKDM/Dokumente/BWP-HWRMP/EN/bwp_En_2d_IFRMP_2021.pdf

[22] Source: Aon plc (2021) Global Catastrophe Recap: July 2021, p. 7-8: https://info.aon.de/wp-content/uploads/Aon-July-Global-Recap.pdf

[23] https://www.iksr.org/fileadmin/user_upload/DKDM/Dokumente/BWP-HWRMP/EN/bwp_En_1st_FD_report_Update_2018.pdf

[24] ICPR Technical Report No. 188 (2011) and ICPR Technical Report No. 219 (2015): https://www.iksr.org/en/topics/climate-change-in-the-rhine-catchment

[25] https://www.iksr.org/en/public-relations/documents/archive/technical-reports/reports-and-brochures-individual-presentation/297-climate-change-induced-discharge-scenarios-for-the-rhine-basin

[26] https://www.chr-khr.org/en/project/snow-and-glacier-melt-rhine-river-asg-ii-2018-2021

Study results for the Rhine basin

Like previous ICPR studies, but now based on the latest national climate studies, the 5th IPCC Assessment Report and in some cases with a wider span of results, the latest ICPR study 2024 summarises that climate change will lead to changes in precipitation and discharge compared to the reference period for the present (1981-2010) with rising temperatures in the Rhine catchment by 2060 (+1 °C to + 2.5 °C) and by 2100 (+3 °C to +5 °C) (see Table 3). The changes in discharge regimes (see Chapter 1.2) show increasingly rain-fed and less snow- or glacier-fed discharge regimes in the Rhine catchment. As a result, summer flows decrease and winter flows increase, whereby the mean annual flow remains almost unchanged.

Table 3: Likely impact of climate change up to 2060

Synthesis of the likely impacts of climate change on precipitation and discharge up to 2060

a. in the hydrological winter half-year:
   - Increased precipitation in winter and spring
   - Increased discharges (up to approx. 30 %)

b. in the hydrological summer half-year:
   - Decreased precipitation (but probably more intense and more frequent heavy rainfall events in summer)[27]
   - Decreased discharges (up to approx. 30 %)
   - Increased drought and low water periods.

c. Increased precipitation events favouring flooding, potentially resulting in higher discharges, particularly during winter. The general trend also points to increases annual flood discharges[28].

According to the current state of knowledge, and even if uncertainty increases at the same time, **all trends** in the above-mentioned parameters (temperature and discharge) by 2060, **are expected to be more pronounced by 2100** (see Table 3).

Even if observations in recent decades show a decrease in flood events due to the accumulation of dry years, it is to be expected that there will generally be further impacts on flood discharge in the future. This may also have a direct effect on flood risk management, in particular on flood protection, due to changes in flood discharge peaks, duration and frequency and the resulting possible alteration of flood risk.

[27] The ICPR Technical Report No. 297 published in 2024 only dealt with heavy rainfall and flash floods in passing, and there is still a considerable need for research into these phenomena. Nevertheless, first models show that heavy rainfall events will become more intense and more frequent with climate change. In summer in particular, the intensity of such events could increase by 10 % to 30 %. A larger proportion of summer precipitation will fall as heavy rain, which increases the risk of flash floods.

[28] Information (*see also Annex 1 and further details in Report No. 297*): This applies to the mean annual flood discharge (or "mean annual high flow" - MHQ) and, except for the Basel gauge, also to flood discharges with an annuality of 10, 100 and 1000 (HQ10, HQ100 and HQ1000). The span of results and uncertainties in relation to these parameters are particularly large, as the climate models currently available are subject to considerable uncertainties, which manifest themselves in systematic deviations in model calculations for known reference periods, particularly in the case of precipitation (plausibility, statistical uncertainties). As a result, the predictions about the possible development of extreme precipitation values and the resulting flood situations have so far shown considerable bandwidths.

2. Exchange on methods and state of the preliminary flood risk assessment in the states of the IRBD Rhine according to FD Article 4, Par. 3

2.1 National method of the preliminary flood risk assessment

As required by FD Article 3, Par. 3, the authorities in charge in the member states of the IRBD Rhine have exchanged relevant information.

Due to differing legal and technical basis of flood protection in the different member states in the Rhine catchment there is no uniform approach to a preliminary flood risk assessment.

The national methodology in the countries of the IRBD Rhine is summarised below.

Netherlands (Rhine):

For the 1st period under report, the Netherlands have applied the transitional regulation of the directive (FD Article 13, Par. 1b) and have drafted maps and plans for the entire territory. For the 2nd period under report, the Netherlands have made a preliminary flood risk assessment (so-called "VORB") in accordance with FD Article 4 and identified the potentially significant flood risk areas (so-called "GPSOR") in accordance with FD Article 5. In the second cycle, the flood risks for each flood type were quantified indicatively for a list of characteristics: e.g. extent of flooding, maximum water depth, number of people and victims affected, economic damage, sensitive objects and areas. In addition, the historical floods, the expected future development and the availability of data for flood hazard and risk maps were also described for each flood type. In order to detect possible adverse effects of future floods, model calculations and knowledge of water management have been made use of. This has been done for situations, in which protection systems (dunes, dams, sluices, impoundments, dikes) protect land against floods and for situations, in which water may unhindered flood land. For the 1st situation, there is a potentially significant flood risk for areas protected by primary protections systems against floods originating from the main water system (e.g. North Sea, Rhine and Maas). National legal standards apply to these protection works. Areas protected against floods by regional (secondary) protection works and for which the standards of the province apply are also prone to potentially significant flood risks. Floods of regional transboundary waters also belong to this group. Flood events due to sewage systems and emerging groundwater do not represent any potentially significant flood risk.

In the third cycle, the indicative quantification of risks was not carried out again, as there was not significantly more simulation data available in the last six years. In the third cycle, the potentially significant flood risk areas in particular were updated by adding flooding from regional water systems that are not protected by defences and flooding due to heavy rainfall. With increasing precipitation extremes due to climate change, it is more likely that regional water systems will overflow their banks, leading to more frequent flooding. The identification of flood risks for regional water systems is important for future spatial planning. Many floodplains - even if they are only of limited size - are currently not indicated as flood prone areas on national maps.

Coordination with Germany on the main stream of the Rhine and transboundary waters also took place in the third cycle.

Germany:

The common basis for carrying out the preliminary flood risk assessment in Germany is the LAWA[29] recommendations for reviewing the flood risk assessment and risk areas according to the FD[30] . The procedure harmonised for Germany in the Standing Committee "Flood Protection and Hydrology" of LAWA (LAWA-AH) is applied for the Rhine and its tributaries based on the results of the PFRA 2018.

The review is based on the water network equally serving as a basis for the WFD (catchment > 10 km²), resp. waters which are known for floods in the past and which, from an expert point of view, may cause significantly adverse consequences in case of future floods. Due to this approach, all important main waters and tributaries were included. The banks of Lake Constance were equally included.

Within the flood risk assessment and based on FD Article 2, the following different types of floods are considered as significant: Fluvial floods and flooding from groundwater in alluvial areas. Pluvial floods following heavy rainfall are not defined as significant, but as a general risk, as such events may occur anywhere and at any time. Flooding from artificial water-bearing infrastructure is also not considered as significant.

The entire process was accompanied by water management experts and the results were finally checked for plausibility.

France:

In 2011, the areas according to FD Article 4 were selected due to the estimated extent of potential floods (so-called "EAIP") and based on criteria for the importance of local action.
For the 2nd cycle of the FD the review of the preliminary flood risk assessment (so-called "EPRI") has led to a slight revision without any new EAIP-calculation. In addition to the floods along surface waters taken into account by the EAIP within the preliminary assessment of flood risk during the first assessment cycle, the preliminary flood assessment 2018 includes an informative map of the rise of groundwater.
The updated list of areas identified according to FD Article 5 is based on state expertise:

- concerning local knowledge, as far as available,
- concerning proposed amendments of parties involved in the implementation of the FD during the coordination.

At the end of this process, the amendment of the list of areas identified according to FD Article 5 is determined after the consultation of parties involved and those taking part in the FD implementation procedure.

For the 3rd cycle of the FD, the review of the EPRI led to a revision without recalculation of the EAIPs. The assets (objects) were assessed again, for each individual municipality, on the basis of 60 indicators calculated at national level. The observation of significant events that have occurred since 2018 led to the inclusion of one new event (flooding due to surface runoff caused by heavy thunderstorms in May/June 2018).

In addition, the list of TRIs[31] drawn up in 2012 was reviewed by updating the identification of the EPRI's assets (objects) with the indicators calculated at national level in 2023 by the "Centre d'études et d'expertise sur les risques, l'environnement, la mobilité et l'aménagement (Cerema)" for the population and residential buildings and by the "Service des données, études et statistiques du ministère en charge de l'environnement (SDES)". The increase in the number of significant assets at risk of flooding in the Colmar area since 2012 and the expected evolution of damages have justified the establishment of a new TRI for this area. A ninth TRI (TRI "Agglomération Colmarienne") in the French part of the Rhine river basin district (level A) was therefore added to the list of TRIs adopted by the "river basin coordinating prefect" on 22 November 2024.

[29] Federal states working group on water (LAWA)

[30] Available at: https://www.lawa.de/documents/empfehlungen-bewertung-hw-risiko-barrierefrei_2_1701681052.pdf

[31] " Territoires à risques importants d'inondation - TRI " : Areas with significant flood risks

Luxembourg:

The preliminary flood risk assessment in Luxembourg is carried out in accordance with FD Article 4. The methodology is based on a damage potential study of the three flood scenarios. In addition, assets (objects) located within the flood zones were also included.

All water bodies designated as areas at risk during the second cycle of the Flood Risk Management Plan are assessed.

Belgium (Wallonia region):

Wallonia applied FD Article 13 for the first management cycle according to the FD, as, at that time, a flood risk map (1st issue 2007) already existed showing that the entire territory is prone to flood risk.

For the second cycle, Wallonia has made a preliminary assessment according to FD Article 4.

In this connection, historical floods with significant impact when occurring and which most probably will again occur in the future were selected. In this connection, Wallonia chose 1993 as pivotal year. Thus, all historic flood events which occurred before 1993 and are assessed as significant have been entered into a list together with their date of occurrence and a short description of the event and were included into the preliminary assessment. Historical floods after 1993 are described much more in detail, in particular, as far as the analysis of adverse consequences of these events are concerned. All in all, 12 flood events which occurred after 1993 were selected and analysed in detail.

Based on Article 4, Par. 2 (d) of the directive, Wallonia equally analysed future flood events and their potential consequences. As required by the directive, the effects of climate change and long-term spatial developments have been taken into account. For the analysis of potential adverse effects of future floods the map layer representing the extent of flooding areas for the scenario HQextreme has regionally been cross-matched with the sector plan, which is the most important tool for spatial planning in Wallonia . The main objective of the sector plan is to determine land use at a scale 1/10,000, in order to secure a harmonic development of human activities and to avoid excessive use of space. Thus, long-term spatial development is comprehensively taken into account. As already explained, the extreme scenario for flooding areas (Qextreme) takes into account climate change and is supposed to become the scenario for the 100 years return period by 2100. For surface runoff pathways on which discharge will concentrate, a 20 m buffer zone was applied.

The process leads to the following preliminary assessment for Wallonia: Since 1993, all 262 municipalities in the region Wallonia have experienced at least one flood event caused by floods along surface waters or by surface runoff. Thus, the 15 sub-basins in Wallonia are considered to be potential areas at risk.

Note: At the time of finalising this report of the IRBD Rhine in December 2024, no new information was available on a possible update of the significant flood risk areas in the third cycle. It is assumed that the only watercourse in Wallonia affected by level A of the IRBD Rhine, the Sûre, is still designated as a significant flood risk area along its entire length in Wallonia (see map in Chapter 3.2 and updated links in Chapter 3.3).

Liechtenstein:

On the one hand, the assessment of flood risk is based on the national hazard mapping and the risk map derived thereof for inland waters and revised during 2015-2018, on the other it is based on the clarification of hazards related to the Alpine Rhine[32] initiated by the International Government Commission for the Alpine Rhine (IRKA).

[32] Hydrologie Alpenrhein, Juli 2000; Schadenrisiken und Schutzmaßnahmen im Alpenrheintal, Juli 2008

Austria:

In Austria, the review and updating of the preliminary flood risk assessment for the 2nd cycle and the resulting identification of areas of potentially significant flood risk (APSFR) was accomplished in time. Apart from the linear designation of the significant flood areas, surface-related information is also made available to the population based on the preliminary flood risk assessment. In order to increase flood risk awareness, potentially affected persons in flood areas are represented for each municipality[33]. Apart from assessing fluvial floods leading to determining the areas of potentially significant flood risk, hazard indication maps were drafted for the process of pluvial floods (surface runoff) and published to create awareness. This approach was maintained for the 3rd cycle, whereby the data basis was updated and the hazard indication map for surface runoff was recalculated using a 2D hydrodynamic model. There are currently 386 APSFRs.

Switzerland:

Since 1991 there has been a legal obligation in Switzerland to draft a hazard mapping for floods (fluvial flooding, lake inundation), landslides, gravitational processes and avalanches (federal law and regulation on hydraulic engineering) and to take into account the resulting hazard maps in guidelines and land use planning as well as all related activities. Thus, basically all waters to be taken into account in the Rhine catchment area are to be classified as potential areas at risk except for those sections of water bodies which are in a natural state and along which damages can therefore not occur. This only applies to two comparatively short sections of the Anterior and Posterior Rhine in the canton Graubünden.
The report published in 2016, "Umgang mit Naturgefahren in der Schweiz" (Dealing with Natural Hazards in Switzerland) also includes information on the risk and damage potential with respect to floods determined on the basis of the risk and land use data available for Switzerland as a whole. About 20 % of the Swiss population is living in areas which might be flood prone. In these very areas, there are some 1.7 million or about 30 % of employments. In addition, about a quarter of the material assets (CHF 840 billion) are located in these areas. This confirms the former assessment that almost all municipalities in Switzerland are potentially affected by flood or debris flow hazards.

With the partial revision of the Hydraulic Engineering Act, the cantons will be obliged to draw up cantonal risk overviews from 2025. These will show which assets are potentially affected and contain quantitative statements on the risks to people and significant material damages. From today's perspective, these risk overviews will be available from 2030.

2.2 State of application of FD Article 4

In 2024, the following states in the IRBD Rhine reviewed and, if necessary, updated the flood risk assessment in accordance with FD Article 4, Par. 1:

- **The Netherlands** carried out the preliminary flood risk assessment for the second time for its entire territory lying within the IRBD Rhine;
- **Germany** for its entire territory lying within the IRBD Rhine;
- **France** for its entire territory within the IRBD Rhine;
- **Luxembourg** for its entire territory lying within the IRBD Rhine;
- **Belgium (Wallonia)** for its entire territory lying within the IRBD Rhine;
- **Austria** for its entire territory lying within the IRBD Rhine;
- **Liechtenstein** for its entire territory (which lies entirely within the IRBD Rhine);
- **Switzerland:** Hazard maps and risk overviews are regularly reviewed within revisions of the guidelines and land use plans and are updated, if the hazard situation has considerably changed (e.g. due to protection measures or changes of the natural conditions).

[33] https://www.bmnt.gv.at/wasser/wisa/fachinformation/hochwasserrisiko.html

3. Coordination based on FD Article 5, Par. 2 and identification of flood risk areas in the IRBD Rhine

3.1. State of Coordination and application of FD Article 5

Since 1998, the transboundary coordination of flood risk management is based on concrete work resulting from the international cooperation of the 9 states in the Rhine catchment.[34]

The exchange of information and coordination takes place among the EU Member States (Germany, France, Netherlands, Luxemburg, Austria, Belgium (Wallonia)) in the IRBD Rhine and includes Liechtenstein and Switzerland. Annex 3 gives a closer description of the existing further bilateral, trilateral or multilateral organs at a regional level.

The updated survey map below (Chapter 3.2) represents the results of the exchange of information according to FD Article 4, Par. 3 in 2024 and the resulting coordination in the IRBD Rhine for the reporting criteria required by FD Article 5, Par. 2. Furthermore, Chapter 3.3 includes links to further detailed national information on areas at risk.

The **survey map** represents the areas of potential significant flood risk identified by the states in the IRBD Rhine according to **FD Article 5**. It shows that, based on the preliminary assessment or existing knowledge (red) for the main stream of the Rhine and its most important tributaries in the IRBD Rhine, part A, catchments > 2,500 km² most river sections present a **potential significant flood risk**.

In France, the following "**areas with significant flood risks**" (territoires à risques importants d'inondation – TRI[35]) have been identified ( ):

- "Greater Strasbourg" (3 watercourses: Bruche[36], Ill, Rhine; area of significant flood risk and with consequences at a national level)
- "Greater Mulhouse" (Ill and Doller[36])
- " Greater Colmar " (Ill, Fecht[36] and Lauch[36])
- "Thionville - Metz - Pont-à-Mousson" (along the Moselle between Blénod-les-Pont-à-Mousson and the French-German-Luxembourgian border)
- "Pont-Saint-Vincent" (Madon[36] [37])
- "Nancy - Damelevières" (Meurthe)
- "Epinal" (Moselle)
- "Saint-Dié – Baccarat" (Meurthe)
- "Saargemünd" (Sarre and Blies[36] in the border area with Saarland - Germany)

In the Netherlands, the following "**areas of potential significant flood risk**" are identified according to FD Article 5:

- Entire section of the main stream and its side arms in the delta (red)
- All areas protected against floods by (primary) protection structures which might be flooded by a flood of the main stream and its side arms ( ).

The map in Chapter 3.2 does not show the additionally designated areas that can only be flooded from the sea (coastal area of the Netherlands), by lakes (IJsselmeer, Markermeer) and by floods in regional water systems.

Only some rare sections of the Anterior and Posterior Rhine in Switzerland and shorter sections of Rhine tributaries do **not present any potential significant flood risk** (green).

[34] https://www.iksr.org/en/topics/floods

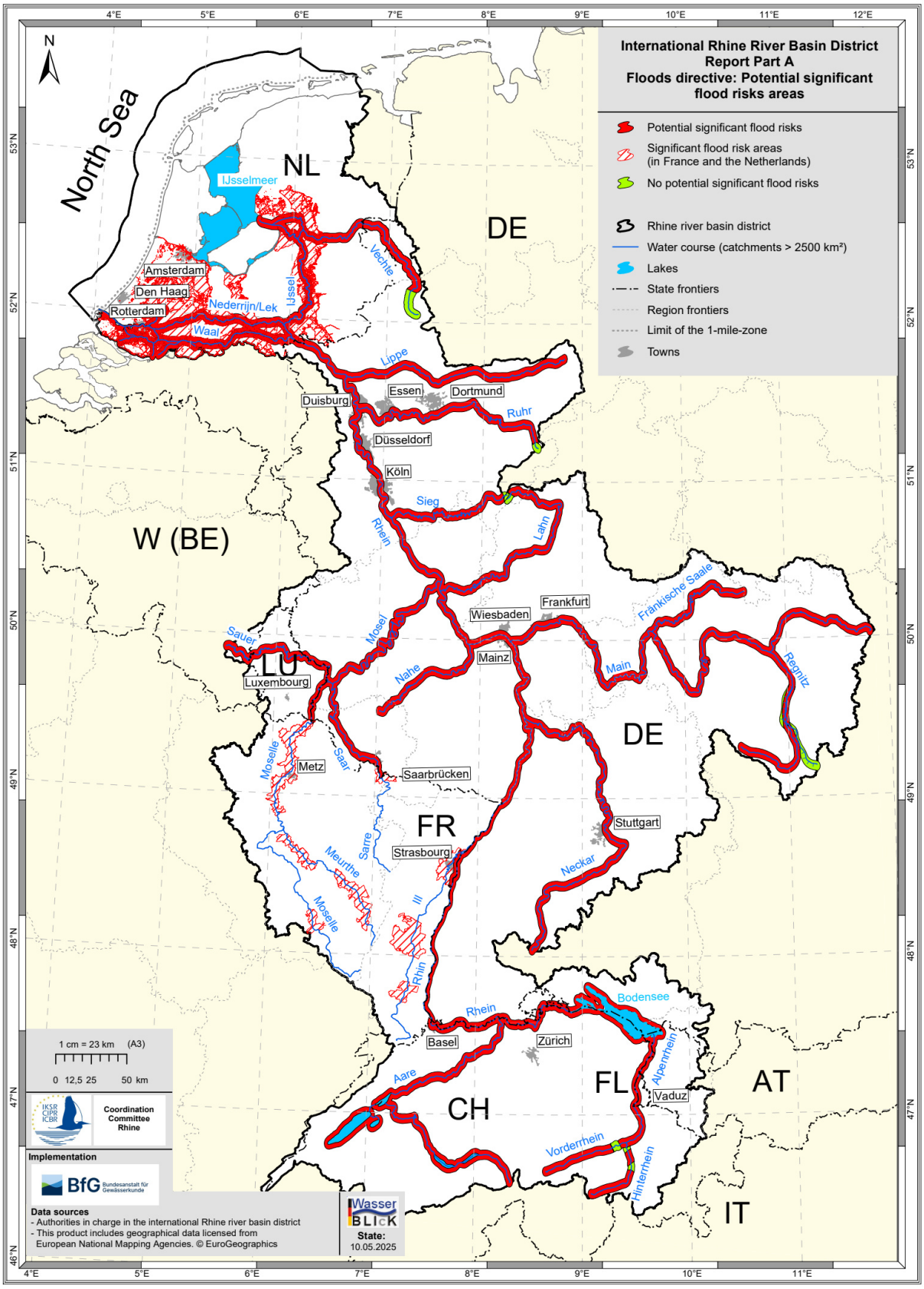
[35] Cf. list of the TRI and the municipalities concerned: see the "Arrêté n° 2024-657 du 22 novembre 2024" (direct link or here for a general link).

[36] Catchments < 2.500 km²

[37] This TRI is not shown on the map in Chapter 3.2, as this TRI only refers to the Madon, a tributary of the Moselle that is not part of the watercourse network of level A of the IRBD Rhine.

3.2. Potentially significant flood risk areas

Survey map on the identification of potentially significant flood risk areas in the IRBD Rhine (part A, catchment > 2,500 km²)



3.3. Directory of detailed information on the preliminary flood risk assessment and identification of flood risk areas in the states[38] and federal states/regions

The Netherlands
VORB (PFRA): Voorlopige overstromingsrisicobeoordeling | Informatiepunt Leefomgeving (iplo.nl)
Maps:
https://www.risicokaart.nl
https://flamingo.bij12.nl/risicokaart-viewer/app/ror2gk
https://flamingo.bij12.nl/risicokaart-viewer/app/ror2mk
https://flamingo.bij12.nl/risicokaart-viewer/app/ror2kk
https://flamingo.bij12.nl/risicokaart-viewer/app/ror2bg
ORBP (FRMP): Overstromingsrisicobeheerplan | Informatiepunt Leefomgeving (iplo.nl)

Germany
LAWA-AH: "Recommendations for the review of the preliminary assessment of flood risk and risk areas under the FD from the 3rd cycle"[39] (fully revised and updated version, status: September 2023): https://www.lawa.de/documents/empfehlungen-bewertung-hw-risiko-barrierefrei_2_1701681052.pdf

Rhine River Basin Community (Flussgebietsgemeinschaft Rhein) (joint federal states):
'Report on the assessment and update of potentially significant flood risk areas in the Rhine River Basin Community ': https://fgg-rhein.de/servlet/is/87525/

Documents or reports per federal state in the Rhine basin:

Baden-Württemberg
https://www.hochwasser.baden-wuerttemberg.de/gebiete-mit-signifikantem-hochwasserrisiko

Bavaria
https://www.lfu.bayern.de/wasser/hw_risikomanagement_umsetzung/forschreibung_risikokulisse/index.htm
https://www.lfu.bayern.de/wasser/hw_risikomanagement_umsetzung/forschreibung_risikokulisse/risikokulisse/index.htm

Hesse
http://hwrm.hessen.de/mapapps/resources/apps/hwrm/index.html?lang=de
https://www.hlnug.de/fileadmin/dokumente/wasser/hochwasser/hwrmp/Uebersichtskarte_HWRM_Hessen_3-Zyklus_600dpi_A3.pdf

Lower Saxony
http://www.hwrm-rl.niedersachsen.de
https://www.umwelt.niedersachsen.de/startseite/themen/wasser/hochwasser_amp_kustenschutz/hochwasserrisikomanagement_richtlinie/bewertung_des_hochwasserrisikos/vorlaufige-bewertung-des-hochwasserrisikos-in-niedersachsen-104681.html

North Rhine-Westphalia
https://www.flussgebiete.nrw.de/risikobewertung-2024
https://www.flussgebiete.nrw.de/system/files/media/document/file/dokumentation_nrw_risikobewertung_z3.pdf

Rhineland-Palatinate
https://hochwassermanagement.rlp.de/unsere-themen/was-macht-das-land/vorlaeufige-bewertung-des-hochwasserrisikos

Saarland
https://www.saarland.de/mukmav/DE/portale/wasser/informationen/hochwasserschutzimsaarland/hochwasserrisikomanagementrichtlinie/dritterzyklushwrmrl

Thuringia
https://umwelt.thueringen.de/themen/boden-wasser-luft-und-laerm/hochwasserschutz

[38] Since Switzerland and Liechtenstein are not members of the EU, they are not obliged to implement the Floods Directive.
[39] In order to harmonise the procedure for the preliminary assessment of flood risk within Germany, a common approach was agreed in the LAWA-AH. This is used for the Rhine and its tributaries, based on the results of the preliminary flood risk assessment from 2018.

France
PFRA: https://www.grand-est.developpement-durable.gouv.fr/evaluation-preliminaire-des-risques-d-inondation-a22783.html?lang=fr

Areas with significant flood risks: https://www.grand-est.developpement-durable.gouv.fr/territoires-a-risques-importants-d-inondations-tri-a22780.html?lang=fr

Arrêté n° 2024-657 du 22 novembre 2024 *(Decree no. 2024-657 of 22 November 2024):* https://www.grand-est.developpement-durable.gouv.fr/IMG/pdf/241122_arr_approb_2024-657_tri_pf67-rep-0241122133501.pdf

Rapport de présentation de l'étape d'identification des TRI sur le Bassin Rhin-Meuse au 3e cycle de la directive " inondation " (2024) *(Presentation report on the identification phase of the TRI in the Rhine-Meuse basin in the 3rd cycle of the FD):* https://www.grand-est.developpement-durable.gouv.fr/IMG/pdf/2024_arrete_prefet_bassin_tri_rhin-meuse_rapport.pdf

Luxembourg
https://eau.gouvernement.lu/fr/administration/directives/directiveinondation.html
https://map.geoportail.lu *(available in FR, DE, EN, LB; see under "Water>Floods directive [FD]>Watercourses with significant flood risks")*

Wallonia
Flood portal: https://environnement.wallonie.be/home/gestion-environnementale/risques-climatiques/inondations.html

Preliminary flood risk assessment : https://environnement.wallonie.be/home/gestion-environnementale/risques-climatiques/inondations/directive-inondation/evaluation-preliminaire-des-risques-dinondations.html

Mapping tools:

General:

https://environnement.wallonie.be/home/gestion-environnementale/risques-climatiques/inondations/directive-inondation/cartographies.html

https://environnement.wallonie.be/home/gestion-environnementale/risques-climatiques/inondations/urbanisme/cartes-inondations/carte-alea-inondation.html

Mapping of areas at risk of flooding in Wallonia (in force):

http://geoportail.wallonie.be/home.html

http://geoapps.wallonie.be/Cigale/Public/#VIEWER=ALEA#BBOX=12070.527474388247,317929.47252561175,7527.9400558801135,192472.05994411992

Arrêté du Gouvernement wallon adoptant les cartographies des zones soumises à l'aléa d'inondation (04 mars 2021) (*Decree of the Walloon Government adopting the mapping of areas at risk of flooding*):

https://wallex.wallonie.be/eli/arrete/2021/03/04/2021010034

Austria
Publication of the implementation of the FD in the Water Information System Austria:
https://info.bml.gv.at/themen/wasser/wisa/hochwasserrisiko.html

Vorarlberg / Working area of Alpine Rhine/Lake Constance: see exchange between the states on the implementation of the FD in the "Alpine Rhine/Lake Constance" coordination group.

Liechtenstein
https://map.geo.llv.li/theme/Naturbedingte%20Risiken
https://www.llv.li/de/landesverwaltung/amt-fuer-bevoelkerungsschutz

Switzerland
www.bafu.admin.ch/gefahrenkarten; http://www.bafu.admin.ch/cartes-dangers; http://www.bafu.admin.ch/carte-pericoli

www.bafu.admin.ch/risikouebersichten; www.bafu.admin.ch/vuesdesrisques; www.bafu.admin.ch/panoramichedeirischi

Annex 1 - "Sensitivity guidance values" for floods (orientation values for possible adaptation measures)[40]

Indicator	**Gauge**	**Observed values (m^3 /s)** *(Reference 1981-2010)*	**Projected changes until 2060 (%)*** *(compared to the reference period)*
Mean annual high flow (MHQ)	Basel	2844	-14 to +17 (0 to +10)
	Maxau	3223	-7 to +30 (+2 to +14)
	Worms	3599	-3 to +43 (+3 to +16)
	Kaub	4547	-3 to +44 (+4 to +19)
	Cologne	6751	-4 to +39 (+5 to +21)
	Lobith	7043	-7 to +36 (+5 to +21)
	Rockenau (Neckar)	*1108*	*-9 to +69* *(-3 to +46)*
	Raunheim (Main)	*1036*	*-20 to +42* *(+8 to +28)*
	Trier (Moselle)	*2081*	*-1 to +35* *(+6 to +21)*
Indicator	**Gauge**	**Projected changes (%) by 2060*** *(compared to reference period 1981-2020)*	
HQ10 ("frequent flood")**	Basel	-8 to +11	
	Maxau	-1 to +20	
	Worms	+2 to +26	
	Kaub	-1 to +24	
	Cologne	-7 to +27	
	Lobith	+8 to +21	
	Rockenau (Neckar)	*0 to +44*	
	Raunheim (Main)	*-18 to +48*	
	Trier (Moselle)	*0 to +31*	

[40] See details in ICPR Technical Report No. 297

Indicator	**Gauge**	**Projected changes (%) by 2060*** ***** *(compared to reference period 1981-2020)*
HQ100 ("medium flood")**	Basel	-12 to +21
	Maxau	-5 to +42
	Worms	-3 to +45
	Kaub	-8 to +56
	Cologne	-26 to +61
	Lobith	+5 to +18
	Rockenau (Neckar)	*-17 to +67*
	Raunheim (Main)	*-24 to +94*
	Trier (Moselle)	*-20 to +49*
HQ1000 ("extreme flood")**	Basel	-25 to +32
	Maxau	-12 to +59
	Worms	-13 to +81
	Kaub	-18 to +89
	Cologne	-39 to +97
	Lobith	+3 to +20
	Rockenau (Neckar)	*-31 to +155*
	Raunheim (Main)	*-27 to +151*
	Trier (Moselle)	*-38 to +94*

**: Notes on the column "Projected changes": Values without brackets represent the complete information on possible discharge changes in the Rhine basin (minimum to maximum changes of all projections); Values in brackets show the span of results that is common to all underlying data sets (intersect of the different ensembles. If there is no intersection, this is marked with '-'.)*

***: Definition based on the scenarios of the FD. See the specific information on the method and uncertainty of these "Indicators for flood extremes" in ICPR Technical Report No. 297 (Chapter 2.2).*

****: The absolute reference values of the discharge used to calculate the trends are based on the data in ICPR Report No. 297 and do not necessarily correspond to the officially agreed values (e.g. as part of the national implementation of the EU Floods Directive; see Annex 2 of this report). To avoid confusion, no absolute values are given here.*

Annex 2 - Coordinated discharge values for 3 flood scenarios/probabilities according to the FD (as of 13 October 2023)

Rhine stretch[41]	High probability	Medium probability	Low probability*
Iffezheim to Neckar[42]	4,100 m³/s	5,000 m³/s	6,500 m³/s
from the confluence of the Neckar	4,750 m³/s	6,000 m³/s	7,600 m³/s
from the confluence of the Main	5,700 m³/s	7,900 m³/s	10,300 m³/s
from the confluence of the Nahe	5,800 m³/s	8,000 m³/s	10,400 m³/s
from the confluence of the Moselle	8,810 m³/s	11,850 m³/s	15,250 m³/s
from the confluence of the Sieg	8,900 m³/s	11,700 m³/s [43]	15,300 m³/s
from the confluence of the Ruhr	9,380 m³/s	12,200 m³/s	15,800 m³/s
beginning at Lobith	9,320 m³/s	12,700 m³/s	14,100 m³/s

** Note: corresponds to ~ 1,000a without dike overflow except for Lobith[44] , with dike overflow*

[41] Additional information from the FOEN for Basel and CH gauges: The values for the Rhine at Basel and upstream of Basel are still up to date (see ICPR FD report 2019). However, a larger study on extreme flooding in Switzerland is currently underway. The results of this study are expected in the course of 2024. Based on the findings available at that time, the flood values on which the hazard assessment and planning are based will then have to be reviewed.

[42] Note for the French side: In view of the lack of study results for HQ1000, the FR delegation confirms the values in the table. However, it is waiting for the results of an ongoing study on the risk of dike flooding for HQ1000 as part of the PPRI (French urban development plan) downstream of Iffezheim.

[43] The discharge difference between the confluence of the Moselle and the Lower Rhine can be explained by retention effects.

[44] The "exceptional events" scenario with 15,100 m3/s (~ 10,000a, with dike overflow) in Lobith is only used for the FD (only for NL, as 4th (voluntary) flood hazard map).

Annex 3 - Cooperation and coordination in sub-basins

The transboundary coordination in the sense of the FD is not only taking place within the ICPR (part A, catchments > 2,500 km²) but is also granted in sub-basins (parts B, C) based on bilateral/multilateral coordination and agreement. Specific reports describe how transboundary coordination was carried out in the sub-basins. The following organisations or commissions based on corresponding agreements confirm the long-lasting and close international cooperation - among others with respect to flood risk management - in the IRBD Rhine:

- International Intergovernmental Commission Alpine Rhine (Internationale Regierungskommission Alpenrhein - IRKA) (AT, CH, FL)
- International Rhine Regulation of the Joint Rhine Commission (Internationale Rheinregulierung (IRR) der gemeinsamen Rheinkommission (GRK)) (AT, CH)
- Coordination group for the implementation of the FD in the Alpine Rhine/Lake Constance working area of the International Commission for the Protection of Lake Constance (Internationale Gewässerschutzkommission für den Bodensee - IGKB) (AT, DE, CH, FL)
- Permanent Commission of the Upper Rhine, The A-Committee is in charge of the sections upstream of Strasbourg (Ständige Kommission für den Ausbau des Oberrheins zwischen Straßburg / Kehl und Lauterbourg / Neuburgweier) (FR, DE)
- The Working Group on Flood Protection and Hydrology (IH) of the International Commissions for the Protection of the Moselle and the Sarre (FR, DE, LU, Region Wallonia (BE)); Link to the report on the preliminary flood risk assessment: http://www.iksms-cipms.org/servlet/is/20071/
- Permanent German-Dutch transborder river commission (Ständige Deutsch-Niederländische Grenzgewässerkommission) (DE, NL)
- German-Dutch Working Group Floods (DE, NL)
- International Working Group / Steering Group Delta Rhine (AGDR/SGDR) (DE, NL)