International flood risk management plan for the International River Basin District "Rhine" (Part A) (catchment areas > 2.500 km²)

Second cycle of the FD (period 2022-2027)

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Chapter 2 deals specifically with the catchment area (2.1 Description and 2.2 Climate considerations), it includes a review of the previous IFRMP (2.3) and the designation of areas with potentially significant flood risk in the Rhine catchment area (2.4), as well as risk and hazard maps (2.5).

Chapter 3 defines the targets of the FRM Plan at hand.

Chapter 4 lists possible measures concerning flood risk management.

Chapter 5 describes the follow-up of progress and monitoring.

Chapter 6 includes a short description of how information and participation of the public were dealt with when drafting this plan.

Summary

The present International Flood Risk Management Plan (IFRMP) of the international river basin district Rhine (IRBD Rhine) for the second cycle of the FD (2022-2027) is made available to the states in the Rhine catchment area for their reporting to the EU in connection with the FD in accordance with Article 14 (3) of the FD and Part B of the Annex to the FD. It is the result of the coordination during the year 2020 and 2021 at the level of the IRBD Rhine pursuant to Article 7 and 8 and Article 14 (3) of the FD and it serves the EU Member States:

(1) as documentation for the application of Article 14 (3) FD (review and, if required, update of the FRM plans including the elements described in FD part B; see Chapter 2.3 of the plan) in the IRBD Rhine (part A, catchment area > 2,500 km²) during the 2nd cycle;

(2) as proof for the coordination according to Article 7 and 8 FD in the IRBD Rhine covered by the reporting obligation.

In particular, this new plan includes:

- Updates of the reviews carried out since the 1st IFRMP;
- an assessment of progress with respect to achieving the targets of Article 7 (2) of the FD;
- A description and justification of measures stipulated in the 1st IFRMP and their planned implementation, which has only been carried out in part. Note: There is no description of additional measures implemented since the 1st IFRMP, as no such new measures have been defined during this first period (2016-2021).

The 2nd IFRMP is in line with the new programme "Rhine 2040" (2020)[1] which sets as an overarching goal in the field of flood risk management for the Rhine and its major tributaries to reduce flood risks by at least 15% by 2040 compared to 2020 through an optimal combination of measures. The 2nd IFRMP is the first step towards further reducing the flood risk and thus contributes to achieving the goal of the Rhine 2040 programme.

Introduction

There has been transboundary and solidary cooperation on the Rhine since the International Commission for the Protection of the Rhine (ICPR) was founded in 1950. Since 1995 and due to the great floods of the middle and lower stretches of the Rhine in 1993 and 1995 flood protection has been an issue added to ICPR work. In 1998, the joint "Action Plan on Floods" (APF) was drafted as part of the programme Rhine 2020 for a period up to 2020.

The 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 Floods Directive "FD") entered into force on 27 November 2007. According to Article 8 (3) of the FD, for international river basin districts extending beyond the boundaries of the Community, EU Member States shall endeavour to produce one single international flood risk management plan or a set of flood risk management plans coordinated at the level of the international river basin district, following the approach described in Chapter 1.1.2. Accordingly, a first international flood risk management plan for the international river basin district Rhine (IFRMP of the IRBD Rhine[2]) for the period 2015-2021 was published in 2015 with the participation of Switzerland and Liechtenstein, which the countries in the Rhine catchment are supposed to have implemented by end 2021.

The present IFRMP of the IRBD Rhine for the second cycle of the FD (2022-2027) is made available to the states in the Rhine catchment area for their reporting to the EU in connection with the FD in accordance with Article 14 (3) to the FD. It is the result of the coordination during the year 2020 and 2021 at the level of the IRBD Rhine pursuant to Article 7 and 8 and Article 14 (3) of the FD and it serves the EU Member States:

(1) as documentation for the application of Article 14 (3) FD (review and, if required, update of the FRMPs including the elements described in FD part B; see Chapter 2.3 of the plan) in the IRBD Rhine (part A, catchment area > 2,500 km²) during the 2nd cycle;

(2) as proof for the coordination according to Chapter IV, Article 7 and 8 FD in the IRBD Rhine covered by the reporting obligation.

1. Implementation of the FD

1.1 The FD in the international river basin district Rhine

1.1.1 Fundamentals and important principles

The targets of the FD concern the management of flood risk by reducing potential adverse consequences of floods for human health, the environment, cultural heritage and economic activities. When dealing with flood risks, both measures to limit the damage potential and to reduce the probability of flooding must be considered.

Flood risk management is a community task. For this reason, all those involved and affected should develop and consolidate an awareness of the risks associated with floods and maintain this awareness in the long term. These tasks can only be performed jointly and with a clear distribution at all levels (local, regional, national, international).

Flood risk management in the IRBD Rhine is holistic and sustainable; the level of security to be achieved must be ecologically reasonable, economically proportionate and socially acceptable. However, even with an optimal combination of flood risk management measures, there is no absolute security. A residual risk will always exist, e.g. due to extreme flood events beyond the existing level of protection. Being prepared for this situation is part of flood prevention, which goes beyond the sole technical flood protection and includes, for example, disaster preparedness or insurance protection. Through knowledge transfer, improved forecasting and translation of climate change impacts, education, training and exercises for these kinds of situations, a continuous effort is made to limit the remaining risk to an acceptable level. An "acceptable level" or "acceptable risks" in the plan means that the risks are, remain or are made acceptable to society and all (affected) actors. Inversely, "unacceptable risks" are intolerable and must be prevented or reduced.

[1] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32007L0060
[2] https://www.iksr.org/en/eu-directives/floods-directive/flood-risk-management-plan

The flood risk management in the IRBD Rhine and thus also the IFRMP is based on the solidarity principle as well as the values of responsibility, proportionality and synergy with other EU policies. On the basis of the principle of solidarity (FD, Recital 13 on first page) the states should avoid to take measures which due to their extent and their effect considerably increase the flood risk in other districts upstream or downstream in the same river- or sub-catchment as long as these measures are not coordinated between the Member States concerned and a common solution has been found.

To meet this obligation, the states have agreed on the following procedure:

(1) Measures which are known **not to have any transboundary effects** will be planned and implemented regionally/locally;

(2) Information on measures with **transboundary effects** is first exchanged bilaterally or within the framework of river basin commissions for sub-basins (e.g. Mosel-Saar). Eventually, these measures must be coordinated on a bilateral or multilateral level in order to find joint solutions.

(3) The measures mentioned under (2) might also cause **supra-regional effects**. Therefore, such measures must at the same time be included in the mutual exchange of information within the ICPR. Due to this approach, measures with transboundary effects are coordinated throughout the river basin district. The effect of planned measures must be determined in common. Aspects of cost-effectiveness may be taken into account;

The afore described approach is mainly applicable to technical measures such as creating retention areas, dike relocation, room for the river (see Chapter 4.3), measures regulating run-off, the construction or strengthening of dikes, etc.

In practice, the principle of solidarity between states is implemented in various ways: Joint financing and participation in the ICPR as well as in specific studies/projects, measures (e.g. water level reduction measures; cf. Chapter 4.3) and joint programmes (e.g. Integrated Rhine Programme, RHESI) from which all participating states benefit.

1.1.2 Implementation of the FD in the IRBD Rhine

The EU Member States are in charge of implementing the FD and of reporting to the EU Commission (see list of competent national authorities in Annex 2). Nevertheless, the 14th Conference of Rhine Ministers on 18 October 2007 commissioned the ICPR, as for the European Water Framework Directive[3] (WFD), to undertake the necessary coordination, harmonization and information exchange of flood management at the level of the International River Basin District Rhine (IRBD Rhine) between the Member States of the EU, including Switzerland and Liechtenstein, for the implementation of the FD.

The IRBD Rhine, like the WFD, refers to the water network of the so-called A-level (or "Part A"), which corresponds to the main stream of the Rhine from its source to the North Sea estuary including its main tributaries with catchment areas of more than 2,500 km² (see list in Table 1 and map in Figure 2). The majority of the measures, which are described in chapter 4, however refer to the main stream of the Rhine.

The jointly coordinated implementation of the FD in the IRBD Rhine focusses on floods along surface waters including lakes and thus on fluvial floods.

As a non-EU member, Switzerland is not obliged to implement the FD. Liechtenstein is also not obliged to implement it, as this Directive has not been incorporated into the EEA Agreement for lack of EEA relevance. As is the case within the implementation of the WFD, and based on national law, Switzerland and Liechtenstein support the coordination of the EU Member States with respect to implementing the FD.

In order to fulfil the obligation to coordinate determined by the FD, the states and Länder/regions with a share in the IRBD Rhine following the principle of subsidiarity have drafted a FRMP for the period 2022-2027. This was done after updating the areas with potential significant flood risk and updating the flood hazard maps and flood risk maps for these areas and reviewing the first international flood risk management plan (IFRMP) 2015-2021 for the IRBD. The 2nd IFRMP comprises:

[3] Directive 2000/60/EC establishing a framework for Community action in the field of water policy

- The present subordinate management plan for the network of water bodies (part A): It emphasizes measures with transboundary effects and measures which the states estimate to be relevant for the entire river basin;
- As well as national and/or regional management plans as well as such coordinated at the level of international sub-basins (part B)[4]. With respect to taking into account national and regional measures please refer to the national and regional FRMPs (see Annex 3 and 4).

When drafting the IFRMP, the targets and measures of the national and regional FRMPs were analysed and reviewed with respect to their compatibility. The analysis showed that these are compatible (see Annex 3).

1.2 Coordinating the FD with the WFD

According to FD Article 9 the states, federal states and regions in the IRBD Rhine are obliged to take reasonable measures to coordinate the implementation of the FD with that of the WFD, focussing on possibilities to improve the efficiency and exchange of information and to achieve synergies and joint advantages regarding the environment targets of WFD Article 4. Within this framework, the preparation of the 2nd IFRMP was coordinated with the preparation of the 3rd management plan of IRBD Rhine[5].

Measures in the IRBD Rhine are supposed to enhance possible synergies with environment targets of the WFD and to reduce environmental effects of measures likely to lead to a deterioration of the ecological state of water bodies to a minimum. The final report No. 260[6] of the ICPR Workshop 2018 of the working groups Flood and Low Water and Ecology on "Flood prevention and water body upgrading in the Rhine catchment area - challenges and success factors" gives a detailed description of a series of win-win measures in the Rhine catchment area. They may result of a combination of water level reduction measures (see Chapter 4.3) and renaturation measures.

In the end, not only ecological synergy effects for ecology are being looked at, but an improvement of the quality of life, living and work, in short, an improvement of the living space on the whole is strived for.

1.3 Link to the ICPR-Programme "Rhine 2040"

At the 16th Conference of Rhine Ministers[7] on 13 February 2020 in Amsterdam the Ministers and the Representative of the European Commission on behalf of the European Union adopted the programme "Rhine 2040" entitled "The Rhine and its Catchment: sustainably managed and climate-resilient". The program represents the working basis of the ICPR for the next 20 years and contains ambitious goals to be achieved together for the further improvement of the state of the Rhine and its catchment area.

The "Rhine 2040" programme corresponds to a voluntary commitment of the states and sets a broader framework for flood risk management until 2040, i.e. in the medium/long term. The concrete organizational specifications for the implementation of "Rhine 2040" were discussed in connection with the work plan of the ICPR and its groups for the period 2022-2027 from the end of 2020. It can already be stated that the IFRMP of IRBD Rhine makes an important contribution to the implementation of the programme "Rhine 2040" and its risk reduction goal for the period 2022-2027. This period corresponds to about one third of the term of Rhine 2040.

In the field of flood risk management, the overarching objective of the "Rhine 2040" programme is to reduce the flood risks **on the Rhine and its major tributaries by at least 15% by 2040 compared to 2020 through an optimal combination of measures.** In order to achieve the above-mentioned goal, all actors are supposed to contribute to its implementation and to take the corresponding national measures. If possible, these are to be linked to nature-based solutions and/or ecological improvement. Furthermore, and due to the

[4] For example, catchment of Moselle and Sarre (work of the International Commission for the Protection of the Moselle and the Sarre (ICPMS))
[5] 3rd Management plan of the IRBD Rhine: https://www.iksr.org/en/eu-directives/european-water-framework-directive
[6] https://www.iksr.org/en/public-relations/events/flood-prevention-and-river-restoration-in-the-rhine-catchment
[7] See 16th Conference of Rhine Ministers, communiqué, press release and Rhine 2040-programme here: https://www.iksr.org/en/icpr/rhine-2040

progressing climate change, the Conference of Rhine Ministers charged the ICPR to update its Strategy for adapting to Climate Change by 2025 in coordination with the present and future national climate change adaptation strategies. The results of the present and of the next adaptation strategy are to be taken into account within the future management cycles of the WFD and FD (see Chapter 2.2).

The overarching objective of flood risk reduction is underpinned by 7 so-called "specific goals" and a total of 16 accompanying measures, which are supported by all states of the Rhine catchment area. Objectives and measures were also defined in other areas related to flooding, such as climate change adaptation, but also water quality and ecology.

The principles and objectives of the IFRMP (see Chapter 1.1. and Chapter 3) are consistent with the long-term objectives of the "Rhine 2040" programme (see complete overview in Annexes 5 and 9).
The same applies to the measures defined in the IFRMP (see Chapter 4 and Annexes 8 and 9), which were coordinated with the measures of the "Rhine 2040" programme and contribute to the "Rhine 2040" programme. The review of the implementation and progress of the plan will include a report on the achievement of the "Rhine 2040" objectives.

One of the most important foundations of the "Rhine 2040" programme is the balance[8] of the "Rhine 2020" programme, including the Action Plan on Floods for the period 1995-2020. The balance shows which goals of the APF have been achieved, where the future challenges lie and where even greater efforts are needed. In this context, and concerning the issue of floods and climate change, the ministers of the states in the Rhine catchment area stated in the Communiqué of the 16th Rhine Ministerial Conference:

- compared to 1995, flood risk has been reduced by 25 % by 2020, in particular due to flood retention measures.
- further measures to reduce flood risk and to retain floods and a stronger interlinking of these measures with ecological improvement of water bodies are required.
- the ever more obvious effects of climate change on, among other things, the discharge regime (floods and low water) and the water temperature must in future be given more attention in all ICPR working areas, as these effects can have a negative impact on water quality and ecosystems, as well as on the utilisation functions of the Rhine.

[8]See 16th Conference of Rhine Ministers, communiqué and balance of the Action Plan on Floods 1995-2020 here: https://www.iksr.org/en/icpr/rhine-2040

2. Flood risk in the Rhine catchment

2.1 Catchment area and discharge

The Rhine connects the Alps to the North Sea. It is 1,230 km long and is one of the most important rivers in Europe. Nine states have a share in the catchment area of about 200,000 km² (see Table 1).

Table 1: Some characteristics of the Rhine catchment area

Surface	about 200,000 km²
Length main stream Rhine	1,233 km
Mean annual discharge	349 m^3/s (Konstanz), 1,265 m3/s (Karlsruhe-Maxau), 2,290 m^3/s (Rees)[9]
Tributaries: Catchments > 2,500 km^2	Aare, Ill (FR), Neckar, Main (Regnitz, Fränkische Saale), Nahe, Lahn, Mosel (Saar, Meurthe, Sauer), Sieg, Ruhr, Lippe, Vechte
Important lakes	Lake Constance, IJsselmeer
States	EU Member States (7): Italy, Austria, France, Germany, Luxemburg, Belgium, Netherlands; other states (2): Liechtenstein, Switzerland
Inhabitants	More than 60 million
Important uses	Navigation, hydropower, industry (abstraction and discharge), municipal water management (wastewater treatment and rainwater), agriculture, drinking water supply, leisure and nature

In the Rhine catchment, different discharge regimes are overlapping (see Fig. 1).

The southern part near the Alps (Basel gauging station) is characterized by the interplay of snow cover constitution in winter and snow melt and comparatively high precipitation in summer ("snow regime" or nival regime). As a consequence, flood periods mainly occur in summer.

Waters draining the Central Upland region (Neckar, Main, Nahe, Lahn, Moselle, etc; Trier gauging station) are characterised by a "pluvial regime" characterized by floods prevailing in winter.

Since these two regimes overlap, the downstream discharge distribution over the year ("combined regime", Cologne gauging station) is increasingly uniform.

In addition to these seasonal flood events, local or regional heavy rain events can also occur in the entire Rhine catchment, which can lead to short-term flooding in smaller and medium-sized water bodies. In July 2021, a large relatively stationary low-pressure area caused heavy rainfall events, flash floods and inundations, especially in the Dutch province of Limburg, in Wallonia (Belgium), in North Rhine-Westphalia and Rhineland-Palatinate (both in Germany). Luxembourg and parts of Baden-Württemberg (DE), Bavaria (DE), Austria and Switzerland were also affected. The floods in the Rhine river basin claimed more than 180 lives (as of September 2021). The provisional total of housing and transport infrastructure damaged by heavy rain and flooding is more than 21 billion euros, with more than 17 billion euros attributable to Germany.[10]
In response to the natural disaster in 2021, the ICPR will address until 2027 the extent to which heavy rainfall events as a result of climate change can affect flood risk management in the entire river basin.

[9] Source and state: Konstanz and Karlsruhe-Maxau: Information of the flood forecasting centre (regionalisation, state: 01.03.2016); Rees: 1st IFRMP of the IRBD Rhine
[10] Source: Aon plc (2021) Global Catastrophe Recap: July 2021, S. 7-8: http://thoughtleadership.aon.com/Documents/20211008_analytics-if-july-global-recap.pdf

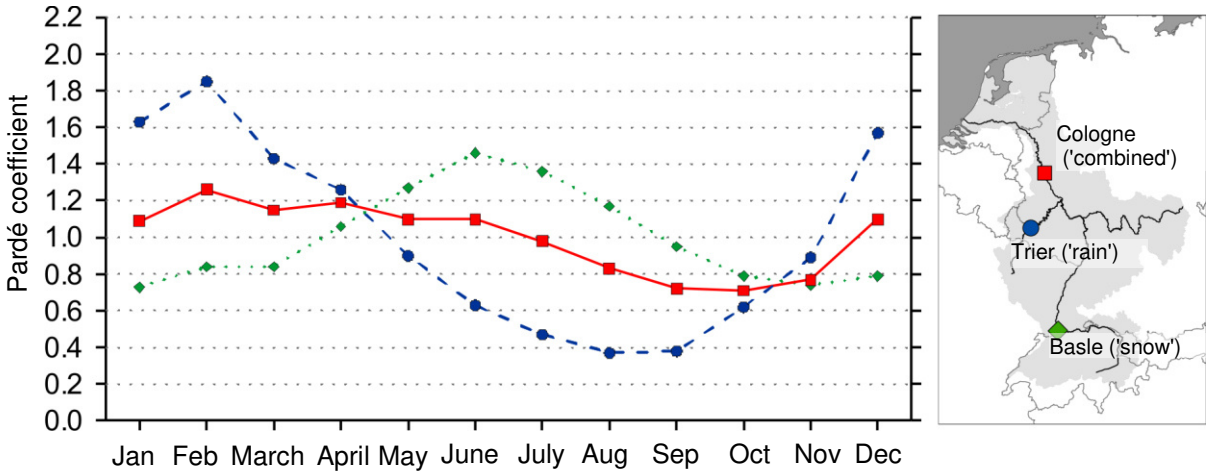

Figure 1: Typical discharge regime in the Rhine catchment according to Pardé[11]; reference period 1961-1990

The river training of the Upper Rhine which began in the 19th century was accomplished in 1977 when the Iffezheim impoundment was built. As a result of this river training, the flood risk downstream (north of the regulated stretch of the Rhine) has considerably increased due to a distinct shortening of the river course, a reduction of potential floodplains by constructing dikes directly on the summer river bed, increased velocity of waves and the overlapping with flood waves from the tributaries. Therefore, after 1977 a targeted construction of retention areas began to fight this man-made increased flood risk (see Chapter 4.3).

The great floods in 1993 and 1995 were due to high discharges in particular from the Moselle catchment and of the Rhine downstream of Koblenz and caused considerable damage on the Lower Rhine (1993: approx. 511 million € and 1995: approx. 281 million €)[12]. In the beginning of February 1995, feared dike breaches caused the evacuation of some 250,000 persons in the Rhine delta. Another great flood was registered on the High Rhine and Upper Rhine in May 1999.
ICPR calculations in 2021[13] concerning the four protected assets according to the FD based on information taken from the national flood risk maps of the ICPR Rhine Atlas 2020[14] summarize to 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 moderate flood probability and some 5.2 million in areas with low flood probability (i.e. extreme floods).
- Cultural heritage: Along the Rhine, there are about 4,612 cultural heritage objects potentially at risk of extreme floods.
- Environment: There are about 2,095 IVU/IED or SEVESO plants potentially threatened by extreme floods along the Rhine. In the extreme flood area, there are 480 bird protection areas (about 129,065 ha), 488 flora-fauna-habitat areas (about 79,911 ha) and 728 water protection areas (about 715,776 ha)(Management Plan 2015, Rhine Atlas 2020) which will normally profit from floods 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 carried out[15] amount to some 54 billion Euro for an extreme event along the entire main stream of the Rhine (without the effect of measures potential damages amount to about 76 billion Euro).

[11] Pardé coefficient = ratio of multi-year monthly discharge to multi-year annual discharge.
[12] Source: http://undine.bafg.de/rhein/extremereignisse/rhein_hw1993.html, http://undine.bafg.de/rhein/extremereignisse/rhein_hw1995.html
[13] See ICPR technical report no. 236 (2015), new calculation results of the EG HIRI (see Annex 10; see ICPR technical report no. 283 - 2021) and Rhine Atlas 2020
[14] see https://geoportal.bafg.de/karten/rhineatlas/
[15] From HIRI calculations 2021 (see Annex 10; see ICPR technical report no. 283) and new Rhine Atlas 2020.

Further information on flood risk and past flood events is found in Chapter 2.4 and the report "Update on the identification of potential significant flood risk areas in the IRBD Rhine"[16].

The potential damage and adverse consequences of floods described above underpin the importance of flood protection. Since 1995 the states have invested more than 14 billion Euro in flood risk management measures (see Annex 1). The present level of flood protection along the main stream of the Rhine depends on the river section and is indicated in Table 2.

Table 2: Present level of protection (expressed in return periods) per section of the Rhine (national information)

Section/River stretch	**Country**	**Protection level (expressed in return periods; unities: Years) for the actual state (2020)** e. g. 300 = flood with a 300 years return period (HQ300)
Alpine Rhine: Reichenau – Sargans	**CH**	**Beyond 300, below 1000**
Alpine Rhine: Sargans - mouth of Ill	**CH/FL (as of km 61 CH/AT)**	**Beyond 1000; decreasing to 1000 as of km 60**
Alpine Rhine: Mouth of Ill - Lake Constance ("International section of the Rhine")	**CH/AT**	**100**
Lake Constance (Germany)	**DE/AT/CH**	**Partly local flood protection with different degrees of protection**
High Rhine	**CH/DE**	**Partly local flood protection with different degrees of protection**
Upper Rhine: Kembs to Iffezheim	**DE/FR**	**> 1000**
Upper Rhine: Iffezheim to Mainz	**DE**	**120 - 150 (making use of existing retention measures)**
Upper Rhine: Mainz to Bingen	**DE**	**One section as summer dike with HQ20, apart from that no continuous line for dikes**
Middle Rhine	**DE**	**Partly local flood protection with different degrees of protection**
Lower Rhine Bonn to Cologne	**DE**	**50- 200**
Lower Rhine Downstream Cologne to border DE-NL	**DE**	**200- 500**
Rhine delta	**NL**	**200- 10,000**

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

2.2 Aspects of climate change

According to Article 14 (4) of the FD, the reviews and updates of risk areas and the FRMP (Article 14 (1) and (3) FD) should take into account the likely effects of climate change on the occurrence of floods. In addition, climate change and climate resilience are focal points of the "Rhine 2040" programme. The present chapter indicates, how climate change is taken into account in the 2nd IFRMP. The national FRMPs (see Annex 3 and 4) contain more detailed information on taking into account climate change as well as references to national approaches and studies. Annex 6 presents national Best Practices, national strategies and projects concerning the adaptation to climate change.

2.2.1 Available investigation results for the Rhine catchment

In summary, available ICPR studies (2011, 2015)[17] show that climate change compared to the reference period for the present (1961-1990) with rising temperatures in the Rhine catchment until 2050 (+1 to +2 °C) and until 2100 (+2 to +4 °C) could possibly lead to changes in precipitation and runoff (see Table 3).

Table 3: Presumed effects of climate change by 2050

Summary of presumed effects of climate change on precipitation and discharge until 2050

a. during the hydrological winter:
- Increased precipitation in winter
- Increased discharge (up to 20 %)
- Early melting of snow/ice/permafrost, shift of the line of snowfall

b. during the hydrological summer:
- Less precipitation (but possibly more often heavy rainfall events in summer)
- Reduced discharge (up to 10 %)
- Increase of low flow periods.

c. More smaller to medium floods, increase of peak flows of rare/extreme floods seem to be possible, but their extent cannot be quantified beyond doubt.

According to the current state of knowledge, and even though the uncertainty is increasing at the same time, all trends of the above parameters (temperature and discharge) by 2050 are expected to worsen by 2100 (further information in ICPR Reports No. 188 and 215).

Note: The climate models presently available are highly uncertain. Partly, there still are considerable systematic deviations in model calculations for a known reference period, in particular concerning precipitation (plausibility, statistical uncertainties). Therefore, indications of possible developments of extreme values for precipitation, and flood situations depending on them still present a considerable bandwidth.

2.2.2 Effects on measures of flood risk management

In 2015, the ICPR published the Strategy for the IRBD Rhine for adapting to climate change (see ICPR Technical report no. 219). To this end the ICPR states agreed upon different climate scenarios and possible fields of action within flood prevention. As part of the "Rhine 2040" programme, the runoff projections (climate scenarios) for 2050 and 2100 will be updated and the adaptation strategy will be continued until 2023 and 2025 respectively. Therefore, it is a joint action in the IFRMP as described in chapter 4.1 (2).

Further effects on flood discharges are to be expected in the future. This may also have immediate effects on the flood risk management, in particular on flood protection by changed peaks, duration and frequency of flood discharges and the resulting change of flood risk.

A major part of measures implemented or planned within the Action Plan on Floods and the 1st IFRMP may be considered as so-called win-win and no-regret measures for flood prevention, water quality and ecology. They contribute to reducing possible adverse effects of climate change. In particular, this applies to measures as improved water retention, renaturation and extensification measures.

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

2.3 Review of the first IFRMP

Within the framework of the review and updating of the FRMP for the IRBD Rhine as well as of the national FRMPs by 22 December 2021 provided for in Article 14 (3) of the FD, including the elements described in FD Part B of the Annex, the states have exchanged and coordinated within the ICPR. Within the ICPR, a review of the implemented measures and the achievement of the objectives from the 1st IFRMP was carried out. The most important points are summarized in this chapter.

The review took into account new developments and knowledge such as the update of the potentially significant flood risk areas, the update of the flood hazard and flood risk maps, the recommendations of the EU Commission[18], the balance of the APF 1995-2020 within the framework of the ICPR programme "Rhine 2020"[19] and the results of the calculations with the instrument "ICPR FloRiAn (Flood Risk Analysis)" concerning the quantitative effect of implemented measures on risk reduction[20]. The results show that, due to nationally implemented flood risk management measures, the risk for all 4 protected assets of the FD has decreased between 2015 and 2020 (see Annex 10). In this connection, the calculated change of flood probability due to water level reduction measures plays a major role[21]. When reviewing the plan, the results of the ICPR workshop staged in 2018 on synergies between flood prevention and rehabilitation of water bodies[22] were taken into account. The reviews referred to in Article 14 (1) and (3) took into account updated knowledge on the likely effects of climate change on flood occurrence and adaptation options. The 2nd IFRMP for the IRBD Rhine is the result of this review process.

In general, it can be stated that the measures foreseen in the first IFRMP have largely been implemented (see Chapter 4 and Annex 1, 7-1, 7-2 and 8). Some measures are permanent tasks and will be continued during the 2nd IFRMP. The implementation of water level reduction measures is slightly behind schedule (see Chapter 4 and Annex 1, 7-1, 7-2 and 8). There are various reasons for why not all measures planned until 2020 have been implemented: technical, administrative and legal obstacles/restrictions. After review in the framework of the ICPR, the achievement of the 4 targets of the 1st IFRMP, after implementing the measures decided on, is assessed as follows:

Targets "(1) Avoid new, unacceptable risks" and "(2) Reduce existing risks to an acceptable level":

- Through the implementation of the measures agreed in the APF and the 1st IFRMP as well as in the national FRMPs, flood risks for the 4 protected assets specified by the FD could be reduced across all 3 flood scenarios by the following orders of magnitude by 2020 compared to 2015[23]:
    - Average reduction by about 36% (economy),
    - Average reduction by about 38 % (man)
    - Average reduction by about 48 % (environment)
    - Average reduction by about 50 % (cultural heritage)
- The awareness of the population of the flood risk has, among others, been increased by the full-coverage publication of flood hazard and flood risk maps, as for example the ICPR Rhine Atlas.
- Water level reduction measures have been implemented, their implementation has begun or new such measures are planned. These measures have largely contributed to the above-mentioned risk reduction. In spite of having realised many water level reduction measures, the target of the APF to lower extreme flood water levels downstream the impounded Upper Rhine by up to 70 cm by 2020 has not been completely achieved.

[18] https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=SWD:2019:0033:FIN:EN:PDF
[19] See 16th Conference of Rhine Ministers, communiqué, press release and Rhine 2040-programme here: https://www.iksr.org/en/icpr/rhine-2040
[20] See Summary of results in Annex 10; see information concerning the tool FloRiAn: https://www.iksr.org/en/topics/floods/flood-risk-tool-florian
[21] See ICPR report no. 229: https://www.iksr.org/en/public-relations/documents/archive/technical-reports/reports-and-brochures-individual-presentation?tx_news_pi1%5Baction%5D=detail&tx_news_pi1%5Bcontroller%5D=News&tx_news_pi1%5Bnews%5D=93&cHash=767c4d2b3dfea123355e0e7f78a24d7f
[22] https://www.iksr.org/en/public-relations/events/flood-prevention-and-river-restoration-in-the-rhine-catchment
[23] Statements are based on ICPR calculations using the tool FloRiAn (see Annex 10)

- In 2021, approximately 350 million m³ of retention volume are available along the Rhine. By 2027 this volume is planned to amount to about 544 million m^3 (state: End of 2021). The implementation of the retention measures to achieve by 2027 must be intensified and accelerated.

Targets "(3) Reduce adverse consequences during a flood event" and "(4) Reduce adverse consequences after a flood event":

- The target to improve the flood forecasting system including to prolong forecasting periods hast been completely achieved.
- An inventory revealed that in the Rhine catchment area interstate crisis management agreements exist and all states have a well-organized disaster control.

During the implementation cycle of the 1st IFRMP, no new/additional measures were decided on. The new measures defined for the 2nd IFRMP or the continued implementation of measures resulting from the 1st IFRMP are listed in Chapter 4 and Annex 8.

2.4 Potentially significant flood risk areas

The updated map in Figure 2 shows the areas with a potential significant flood risk in the Rhine catchment (part A). The areas were updated in 2018 during the 2nd cycle of the FD. The corresponding ICPR report[24] includes further information on areas at risk. According to the survey map, a potential significant flood risk exists along almost all stretches of the Rhine main stream and its most important tributaries. Only some rare sections of the Anterior and Posterior Rhine in Switzerland and some tributaries do not present any potential significant flood risk.

The map does not show the additionally designated areas which may exclusively be inundated by the sea (coastal area of the Netherlands), by floods in regional water systems and by local heavy rainfall events.

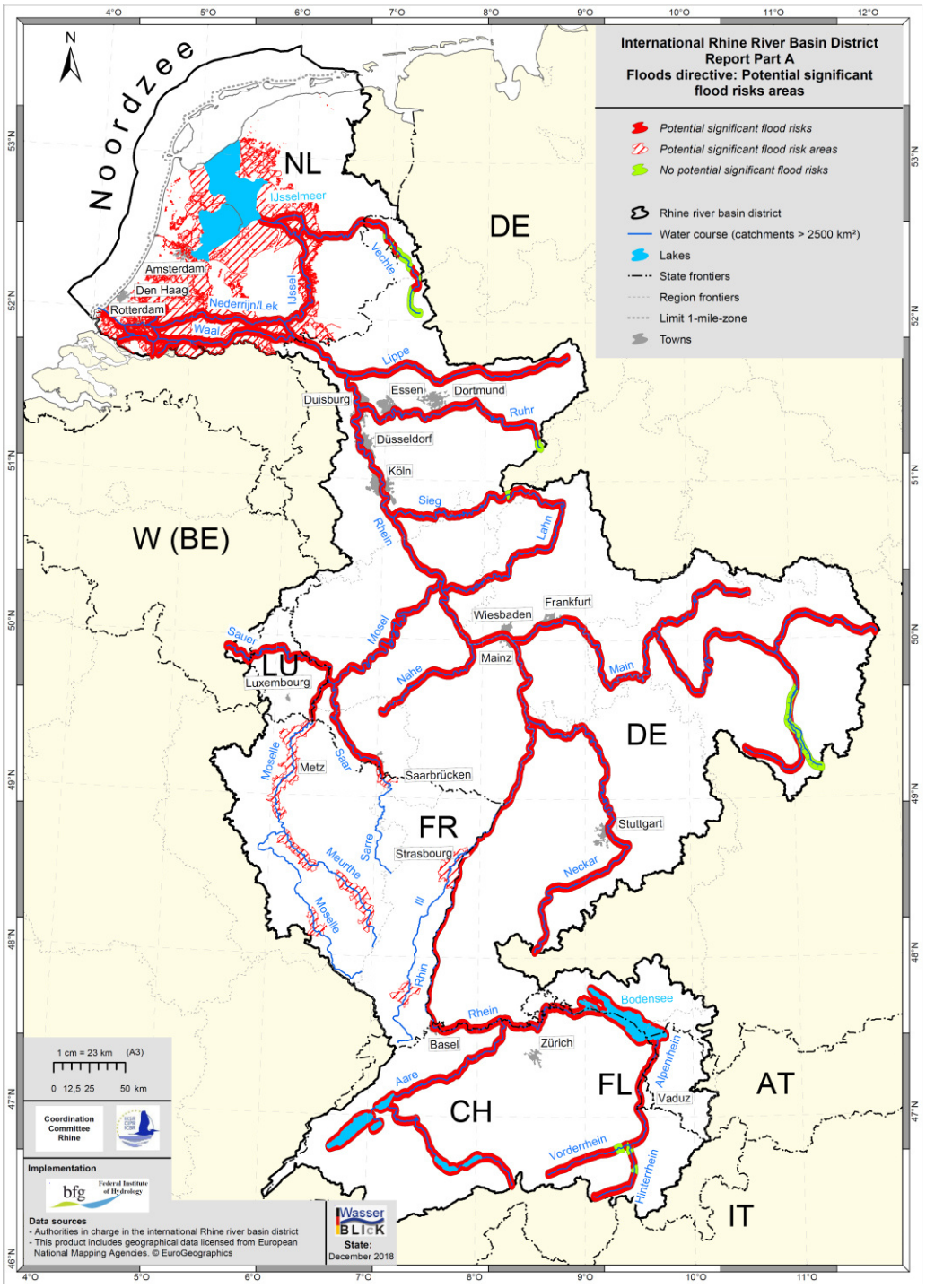

Figure 2: Survey map on the identification of potential significant flood risk areas in the IRBD Rhine (part A)

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

2.5 Flood hazard and flood risk maps

The "Report on the Update of the flood hazard and flood risk maps in the IRBD Rhine"[25] includes the results of the exchange of information 2014-2019 and the flood hazard and flood risk maps updated due to the update of areas with potential significant flood risk (Part A) (see Figure 2). The discharge values for the three flood scenarios for the Rhine main stream, Lake Constance and the IJsselmeer were also internationally coordinated and used for the Rhine Atlas (see chapter 4.1 and figure 3).
The above-mentioned report and the Rhine Atlas[26] include links leading to the national map portals.

3. Targets of flood risk management

The IFRMP (part A) defines the targets and describes measures with transboundary effects and measures which the states concerned esteem to be relevant.

The target of flood risk management is to reduce existing flood risks to a socially acceptable level and to prevent new, unacceptable risks so as to secure living areas and economic areas for the future.

The targets of the IFRMP (part A) take into account the FD and strategies in Member States and regions (see Annex 3). Annex 4 gives a more detailed description of the national FRMPs and their targets.

The 4 targets of the IFRMP (Part A) are based on the main objective of the "Rhine 2040" programme, to reduce the flood risks of the Rhine and its major tributaries by at least 15% by 2040 compared to 2020, as well as the associated 7 so-called "specific goals" and 16 measures of the programme (cf. detailed information on the consistency of the targets of the IFRMP with "Rhine 2040" in Annexes 5 and 9).

The review of achievement of the 4 targets of the plan within the ICPR will include a report on the achievement of the "Rhine 2040" targets. In the following, the four common targets of the IFRMP are indicated, briefly explained and linked to related types of measures. Some measures contribute to more than one target.

3.1 Avoid new, unacceptable risks

The flood risks are to be avoided by sensitizing all actors and affected persons, keeping flood-prone areas clear or adapting new buildings to the flood risks (building precaution) as well as increasing the retention areas on the Rhine and its tributaries, if necessary with flood-adapted use. With this target, the principle of solidarity is particularly taken into account.

3.2 Reduce existing risks to an acceptable level

Technical flood protection (including raising and maintaining the level of protection in areas protected by dikes and other defence infrastructures) and water level reduction measures contribute to limit risks. By making all actors and affected persons aware of the risks, they should act on their own responsibility before a flood event and, for example, take technical measures to protect their property.

3.3 Reduce adverse consequences during a flood event

The adverse consequences during a flood are to be reduced by raising awareness of the need for risk-appropriate behaviour in the event of an incident, improving flood announcement systems and flood forecasting. This includes organizational measures, crisis management and protective measures taken during a flood.

[25] https://www.iksr.org/fileadmin/user_upload/DKDM/Dokumente/BWP-HWRMP/EN/bwp_En_2d_FDre-port_Upd.2019.pdf
[26] see https://www.iksr.org/en/public-relations/documents/archive/maps/rhine-atlas

3.4 Reduce adverse consequences after a flood event

Within the framework of the mainly nationally regulated "post-crisis management", the aim is to ensure a return to the normal situation as quickly as possible through appropriate recovery.

4. Flood risk management

The IFRMP describes measures with transboundary effects and measures for which international coordination and intergovernmental information exchange are important.

The table in Annex 8 shows the general evaluation of the WG H concerning the implementation of the joint measures of the 1st IFRMP, the (new) measures defined for the 2nd IFRMP and the connection of these measures with the 4 targets of the 2nd IFRMP and the 7 specific goals of the "Rhine 2040" programme. Annex 8 shows that the states have implemented most of the measures or that implementation is going on. Most of the measures of the first IFRMP for the IRBD Rhine are being continued during the second IFRMP. Some common measures have been newly defined or added, in particular so as to correspond to "Rhine 2040".

The Table in Annex 9 shows in detail, how measures of the 2nd IFRMP and goals and measures of "Rhine 2040" coincide. Annex 9 demonstrates that targets and measures of the IFRMP cover all targets and measures listed in "Rhine 2040". The measures of the 2nd IFRMP contribute to the reduction of flood risk and enable part of the -15% reduction objective for 2040 to be achieved in the period 2022-2027. Therefore, the measures of the IFRMP contribute to the programme.

4.1 Improved exchange of information and access to information

For their decisions in the field of flood risk management, the states in the Rhine catchment require reliable information tools and a comprehensive and reliable technical background. Knowledge on flood risks and the exchange of information and data are at the basis of flood risk management and contribute to improve the solidarity of those upstream in the Rhine basin with those downstream.

E.g. via recognised observers (NGOs) in the ICPR, the public should be informed and involved in the discussion on planning at an early stage at regional, national and international level.

Concrete joint measures

(1) Improved knowledge on flood risk

In the ICPR there is a regular exchange of experience on new national policy approaches and new technical knowledge of flood risk management (prevention, protection, preparedness and recovery) as well as on important measures implemented. Based on existing methods and data, the FloRiAn tool (see Annex 10) is to be used in the ICPR to calculate the effect of the measures on flood risk at regular intervals, at the latest by the 3rd IFRMP Rhine. This will contribute to proving the target achievement.

(2) Exchange on the development of models and contribution to the updating of the climate change adaptation strategy

The states exchange information among one another as well as with other actors such as the International Commission for the Hydrology of the Rhine basin (CHR) on new developments and results regarding hydraulic and hydrological models (in the Rhine catchment area).

This exchange also concerns possible effects of climate change on the discharge regime of transboundary waters and possible adaptation measures.
According to the "Rhine 2040" programme, the ICPR Strategy for adapting to climate change[27] is to be updated until 2025. To this end, discharge projections for 2050 and 2100 are to be updated by 2023.
In this connection, updated IPCC[28] data, further new national and international knowledge, socio-economic developments and the effect of different uses will be taken into account.

[27] https://www.iksr.org/en/topics/climate-change-in-the-rhine-catchment
[28] IPCC: Intergovernmental Panel on Climate Change

There will also be an exchange within the ICPR on how to deal with heavy rainfall. The importance of this is underlined by the devastating heavy rain and flood events of summer 2021. The measures mentioned in this paragraph related to "Rhine 2040" will be implemented with the help of the Working Group 'Floods and Low Flow' (WG H) within the framework of the IFRMP.

(3) Improve flood awareness

The web-based "Rhine Atlas" with flood hazard maps and flood risk maps for the entire main river from the Alpine Rhine to the North Sea including Lake Constance, the IJsselmeer and the Dutch coasts, updated in 2020, makes it possible to comprehensively inform the population, planners and decision makers about the flood risks on the Rhine or to sensitize them to them (see Figure 3). For details the Rhine Atlas includes links to national map portals. In addition, these data are used for the risk analysis and calculation with the "FloRiAn" tool (see Chapter 2.3 and Annex 10). The Rhine Atlas 2020 will be revised by end 2025, when the national flood hazard maps and flood risk maps are updated.

In addition, awareness-raising activities at the international level, such as the "Floods" topic page on the ICPR website and other public relations activities, are to be intensified. In parallel, the public will be informed at a national, regional or local level. ICPR observers and NGOs as well as inter-municipal actors such as flood partnerships on the Rhine and Moselle shall continue to play an important role in the field of flood prevention and information.

(4) Exchange on national building precaution and flood adaptation measures

To reduce damages, undeveloped floodplains are to be kept free of constructions. New buildings and, where applicable, also existing buildings in flood-prone areas are adapted to the flood risks This can be achieved by flood-adapted construction and / or measures to protect property.Spatial planning and the building industry as well as the building sector are to take into account available knowledge on hazards and damage risks due to floods.

Within the ICPR, a (continuous) exchange of information concerning national building precaution and flood adaptation measures as well as the corresponding national regulations is going on.

(5) Exchange on crisis management and recovery

Good crisis management planning for flood events is important in order to be able to reduce risks during the event. This is a national task of the interior administrations and civil protection. Many activities are now also going on at EU level (see Copernicus programme).

Within the framework of comprehensive flood risk management, an exchange of information is to take place with actors of civil protection and crisis management, as well as an exchange concerning national recovery measures.

Especially in view of the heavy rainfall events and severe flooding in the summer of 2021 in Western and Central Europe, the emphasis must be placed on functioning warning chains in the future. In order to prevent coordination deficiencies, an even closer exchange with responsible stakeholders, e.g. civil protection, will be sought. Information on national and transboundary flood exercises of the past[29], projects and (digital) tools should be gathered and exchanged.

Links with the area of flood forecasting and reporting (e.g. exercises, warnings, etc.) (cf. Chap. 4.2), among others through an exchange with the flood forecasting centres on the Rhine, as well as sensitization (flood information) (cf. Chap. 4.1 (3)) should be investigated and highlighted.

[29] Example: German-Dutch flood exercise Viking (cooperation of disaster control and water management beyond the frontier).

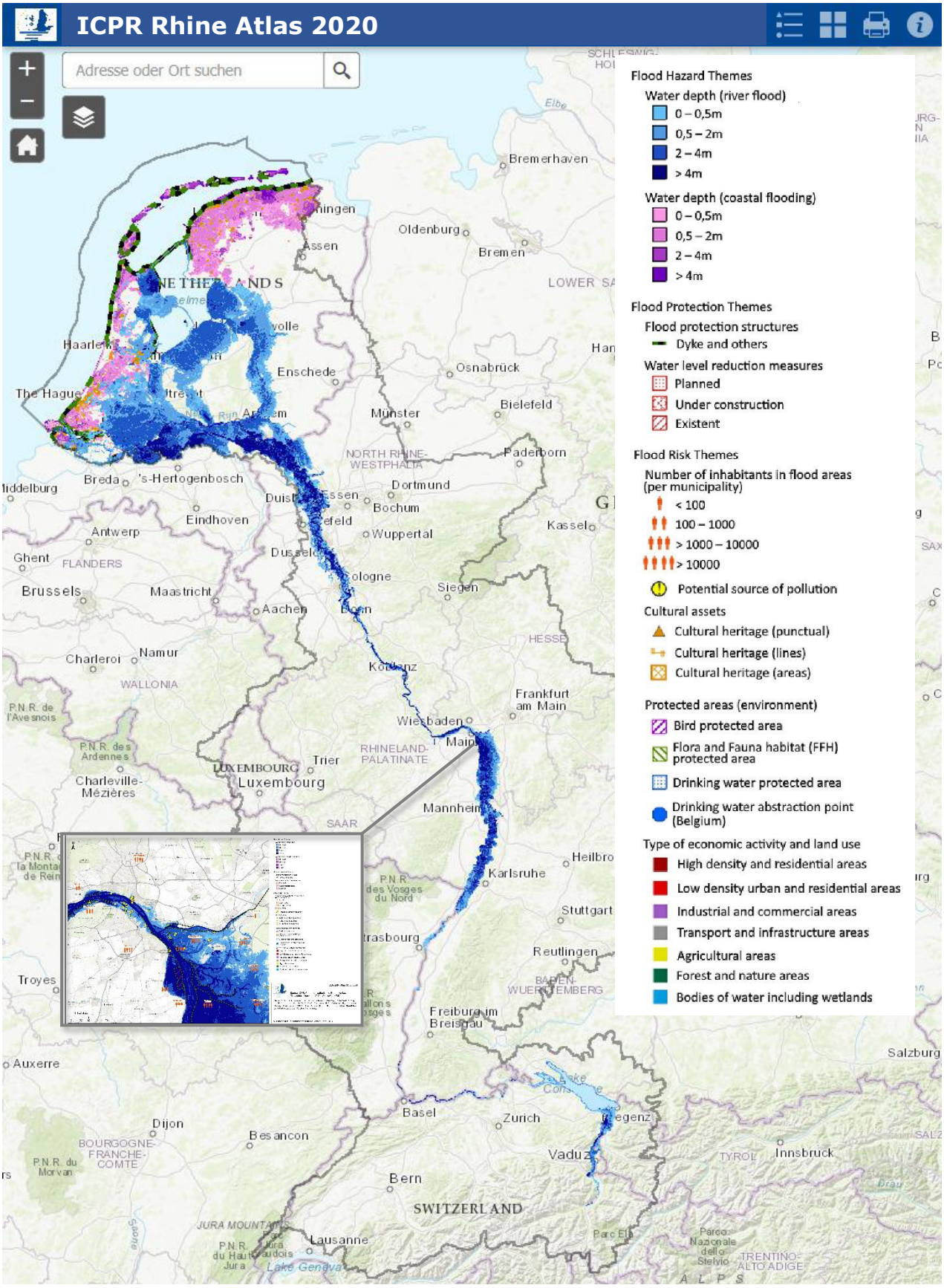

Figure 3: Extract from the ICPR Rhine Atlas 2020 with indication of the flood risks for the main stream of the Rhine *(Note: clicking into the map will open the Rhine Atlas and thus also the national map portals)*

4.2 Improve flood forecasting and flood warning

Flood forecasting, flood announcement and flood warning prolong the preparation and reaction time and thus contribute to reduce damages during flood events.
For flood forecasting, continuous hydrometeorological measurements (including real-time measurements of water levels, runoff and precipitation), model calculations and data exchange are required. Along the main stream of the Rhine, the flood forecasting centres in Switzerland, Germany, France and the Netherlands are in charge of these tasks[30]. The forecasting system for the biggest Rhine tributary, the Moselle and its catchment is taken into account in the IFRMP of the ICPMS (part B).

Concrete joint measures

(1) Improve flood forecasting, flood announcement and flood warning based on the most recent knowledge

Flood forecasting and warning should be guaranteed, functional, practiced and up-to-date everywhere. Aspects of early warning and heavy precipitation/flash floods should also be integrated. Links to sensitization (information of public concerned) and crisis management should be identified and taken into account (see Chapter 4.1 (3) and (5)).

(2) Continue the ongoing international cooperation before and during a flood event

The close cooperation of all flood forecasting services along the Rhine and in its catchment is to be continued. The annual meeting of flood forecasting centres staged by the ICPR is part of the activities of the Working Group Floods and Low Water.

4.3 Implementation of water level reduction measures and keeping areas clear/open

Due to the impact of climate change and the expected increase of the number of flood events and socio-economic developments, measures having an effect on a supra-regional level, such as keeping flood hazard areas clear/open or creating further flood retention areas (room for the river) become even more important. The impact of this kind of measures on reducing water levels and reducing flood probability and thus the flood risk has been analysed and demonstrated within the framework of the ICPR[31]. Wherever possible, all flood protection measures should go hand in hand with river restoration (see Chapter 1.2).
Furthermore, the positive effect of the sediment balance on discharge, river dynamics and flood protection are being mentioned. In this connection, within the ICPR, an exchange is planned for the years to come with the other Working Groups.

The Annexes 7-1 and 7-2 list water level reduction measures implemented by 2021. Some of the measures originally planned to be implemented by 2020 will presumably not be accomplished before in 2027 and are thus part of the 2nd IFRMP for the IRBD Rhine. In order to achieve the greatest possible reduction in water levels, further considerable efforts are required in the Rhine catchment area until 2027 and beyond. The implementation of the measures can be promoted, among other things, by giving greater weight to flooding in regional development and planning procedures (reduction of risks to the common welfare, also from the point of view of impacts of climate change). An interesting national example is Germany with the Federal Spatial Development Plan for Flood Protection[32] (Bundesraumordnungsplan Hochwasserschutz - BRPH; entered into force on 01.09.2021), which provides for the spatial development and securing of areas for flood protection measures and flood-adapted use of flood-prone areas (avoiding new risks). A second example is the pre-emption right in the German Water Resources Act (according to § 99a WHG). It gives the Länder a pre-emption right for plots of land required for flood protection measures.

[30] See map of the flood forecasting centres along the Rhine with links to up-to-date forecasting: https://www.iksr.org/en/topics/floods/flood-warning-and-forecasting-centres/interactive-map
[31] See ICPR Technical Reports no 199, 229 and 236
[32] See www.bmi.bund.de

Concrete joint measures

(1) Implementation of water level reduction measures listed in the Annexes 7-1 and 7-2, which are planned to be implemented by 2027, e.g. (future) retention areas, dike relocation, room for the river, renaturing.

(2) Enhancement of national or regional agreements targeted at keeping floodplains free of all uses/creating discharge corridors; exchange on these activities within the ICPR.

(3) Identification and bundling of possible further water level reduction measures along the Rhine and in its catchment beyond 2027.

(4) Synergies between measures that have a positive impact on flood protection concerns as well as on ecology and water quality - wherever possible - are given preference in the selection of measures; exchange on the interactions between the above-mentioned working fields within the framework of the ICPR.

(5) The points (1) to (4) also include measures in the tributaries and small affluents in the Rhine catchment.

4.4 Summary of national measures

The national FRMPs for the Rhine catchment, but also the FRMPs for part B of the catchment, e.g. Moselle-Sarre give a detailed description of the measures implemented during the first cycle of the FD and those, to be implemented during the second cycle. A more detailed description of the national FRMPs and their measures is listed in Annex 3 and 4.

5. Implementation of the plan and evaluation

The updated and 2nd IFRMP for the IRBD Rhine concerns the period 2022-2027. According to the FD the FRMPs shall be reviewed and if necessary updated every 6 years. This means that the evaluation of the 2nd IFRMP will be accomplished before 22 December 2027. This also applies to the identification of potentially significant flood risk areas by December 2024 and to the flood hazard maps and flood risk maps by December 2025.

The monitoring and assessment of measures implemented within the framework of the 2nd IFRMP will be starting in the ICPR working groups Floods and Low Water and their expert groups in 2022. According to the FD, the next evaluation and update is planned for December 2027.

The effect of all measures carried out at a national level within the second cycle of the Flood Risk Management will have to be identified on a national level and for the IRBD Rhine. This can be done using existing methods and the GIS tool FloRiAn[33].

[33]see Annex 10 and outlook on the effect of planned national measures for the period of the 2nd IFRMP 2022-2027.

6. Public information and consultation

For the information and consultation of the public on the 2nd IFRMP of IRBD Rhine (Part A), the same procedure as for the 1st IFRMP and the three international management plans according to the WFD has been provided for at the international level: the draft has been made available on the ICPR website for public participation from the 22th of December 2020 until the 30th of June 2021. The reports and publications jointly produced at international level on the FD[34], the balance of Rhine 2020 (including APF) and the "Rhine 2040" programme were also available there.

The FD provides for the inclusion and participation of the public at all levels, that is, on the local, regional, national and international level.

In the ICPR, the recognised observers were also already involved in the working groups and thus had the opportunity to bring their concerns into the discussions at an early stage and participate in the products, such as the IFRMP.

Reactions and results of the public information and consultation concerning the plan were bundled and published on the ICPR website by 22 December 2021. The ICPR received a statement on the draft of the 2nd IFRMP from the NGO "Hochwassernotgemeinschaft Rhein (HWNG Rhein)", recognised as observer[35].

The final version of the IFRMP for the IRBD Rhine for the period 2022-2027 was published on the ICPR website by 22 December 2021[36].

[34] https://www.iksr.org/en/eu-directives/floods-directive

[35] The statement was made available on the following page: https://www.iksr.org/en/eu-directives/floods-directive/public-participation
Summary of the statement of the "Hochwassernotgemeinschaft Rhein (HWNG Rhein)": The HWNG Rhein emphasises that the 2nd IFRMP is an important step to advance the interests of flood protection and prevention and to accept the challenges of climate change. From the point of view of the HWNG Rhein, flood prevention to reduce damages and the identification and securing of further retention areas is of particular importance.

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

ANNEXES

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Annex 1 - Balance of the Action Plan on Floods 1995-2020 and State of Flood Risk Management in the IRBD Rhine (Part A)

Note: *Detailed information on the implementation of the APF is to be found in the* ***Balance of the Programme Rhine 2020***[37]*.*

Action targets of the Action Plan on Floods for the target year 2020 compared to 1995		Achievement of target
1	Reduce flood damage risks by 25 % by 2020.	Achieved.
2	Reduce flood levels - Reduce extreme flood levels by up to 70 cm by 2020 downstream the impounded section (60 cm due to water retention along the Rhine and approximately 10 cm due to water retention in the Rhine catchment).	Partly achieved.
3	Increase flood awareness by drafting and spreading flood risk maps for 100 % of flood-prone areas.	Achieved.
4	Improve the flood announcement system: short term improvement of flood announcement systems due to international cooperation. Prolong forecasting periods by 100 % by 2005.	Achieved.

[37] https://www.iksr.org/fileadmin/user_upload/DKDM/Dokumente/Broschueren/EN/bro_En_Assessment_%E2%80%9CRhine_2020%E2%80%9D.pdf

Rhine Action Plan on Floods Overview of measures and implementation 1995-2020		*Cost (million Euros)*
Water retention		
Along the Rhine		
Reactivation of floodplains	140 km²	*2412*
Technical flood retention systems	340 million m³	*899*
In the Rhine catchment		
Nature restoration (river kilometres)	> 5650 km	*>2001*
Reactivation of floodplains	> 1230 km²	
Agricultural extensification	14690 km²	*1537*
Nature development, afforestation	> 1040 km²	*>181*
Technical flood retention systems	55 million m³	*904*
Enhance rainwater infiltration	Improvements, data acquisition problematic	*>10*
Technical flood protection		
Dike maintenance and strengthening, adaptation to the protection level, local flood protection on the Rhine and in the catchment area (river kilometres)	> 2290 km	*>5926*
Preventive planning measures		
Raise awareness	Improvement by conceiving websites, brochures, organisation of events and flood exercises	*>190*
Draft hazard and risk maps	100%	
Flood forecasting		
Improve flood warning and announcement systems	Improvement of systems, data base and public information	*>66*
Prolong forecasting periods	100%	
		>14126 (Total) (ca. 14 billion Euro)

State of information: *February 2020, publication of the balance of the APF 1995-2020 within the Programme Rhine 2020*[38]

[38] https://www.iksr.org/fileadmin/user_upload/DKDM/Dokumente/Broschueren/EN/bro_En_Assessment_%E2%80%9CRhine_2020%E2%80%9D.pdf

Annex 2 - List of the authorities in charge of the implementation of the FD in the IRBD Rhine

Country	**Switzerland**	**Italy**	**Liechtenstein**	**Austria**	**Germany**								**France**	**Luxembourg**	**Belgium**	**Netherlands**
Country		Lombardy region		Vorarlberg	Baden-Württemberg	Bavaria	Hesse	Rhineland-Palatinate	Saarland	North Rhine-Westphalia	Lower Saxony	Thuringia		Luxembourg	Wallonia	
Name of the authority in charge	Switzerland is not obliged to implement the EU Floods Directive (CH) Authority in charge of information / co-ordination: Bundesamt für Umwelt / Federal Office for the Environment	Lombardy region, for great constructions such as dams the state Ministry for Environment (IT)	Liechtenstein is not obliged to implement the FD (LI) Authority in charge of information / coordination: Office for Civil Defence	Federal Ministry for Agriculture, Regions and Tourism	Ministry for Environment, Climate and Energy Baden-Württemberg (UM)	Bavarian Ministry for Environment and Consumer Protection (StMUV)	Hessian Ministry for Environment, Climate Protection, Agriculture and Consumer Protection (HMUKLV)	Ministry for Environment, Energie, Nutrition and Forestry of the Land Rhineland-Palatinate (MUEEF)	Ministry for Environment and Consumer Protection of the Saarland (MUV)	Ministry for Environment, Agriculture, Nature Protection and Consumer Protection of the Land Northrhine-Westphalia (MULNV)	Ministry of Environment, Energy, Construction and Climate Protection of Lower Saxony (MU)	Ministry of Environment, Energy and Nature Protection of Thuringia (TMUEN)	The co-ordinating Prefect for the Rhine-Meuse basin	Ministry of Environment, Climate and Sustainable Development	Walloon Government	Ministry for Infrastructure and Water management, if necessary together with the Ministry of Interior / Royal Affairs and the Ministry of Economy[1)] (NL)
Address of the authority in charge	BAFU / FOEN CH-3003 Bern	Regione Lombardia Via Pola, 14 I - 20125 Milano	ABS Postfach 684 LI-9490 Vaduz	Stubenring 1 A - 1012 Wien	Kernerplatz 9 D-70182 Stuttgart	Rosenkavalierplatz 2 D-81925 München	Mainzer Str. 80 D-65189 Wiesbaden	Kaiser-Friedrich-Str. 1 D-55116 Mainz	Keplerstr. 18 D-66117 Saarbrücken	Schwannstr. 3 D-40476 Düsseldorf	Archivstr. 2 D-30169 Hannover	Beethovenstraße 3, D-99096 Erfurt	5 Place de la Préfecture, 67073 Strasbourg CEDEX	4, Place de l'Europe L-1499 Luxemburg	Rue Mazy, 25* 27 B -5100 Namur (Jambes)	Postbus 20901 2.500 EX Den Haag Netherlands
Legal status of the authority in charge	National regulatory authority	Supreme water authority of the region	National regulatory authority	Supreme water authority of the Republic of Austria	Supreme water authority of the federal state	Supreme water authority of the federal state	Supreme water authority of the federal state	Supreme water authority of the federal state	Supreme water authority of the federal state	Supreme water authority of the federal state	Supreme water authority of the federal state	Supreme water authority of the federal state	The co-ordinating Prefect for the Catchment area co-ordinates and implements the state policy concerning water management and legal compliance (Article L 213- 3 of the Environmental Code)		Regional government	Supreme state authority for water management
Competencies	Legal and technical control, co-ordination	Legal and technical control, co-ordination	Legal and technical control, co-ordination	Legal and technical control, co-ordination	Legal and technical control, co-ordination	Legal and technical control, co-ordination	Legal and technical control, co-ordination	Legal and technical control, co-ordination	Legal and technical control, co-ordination	Legal and technical control, co-ordination	Legal and technical control, co-ordination	Legal and technical control, co-ordination	Implementation and co-ordination of state policy concerning water management and legal compliance	Legal and technical control	Political programming, implementation, administration and coordination	Political planning, execution, control and coordination
Number of lower-level administrations resp. administrative units	26 cantons	11 provinces and 1546 towns	11 municipalities	1 Governor Vorarlberg (Bregenz)	48 (4 regional councils, 44 towns / rural districts)	56 (5 governments, 41 subordinate water agencies, Bavarian Federal Authority for Environment (LfU), 9 agencies for water management)	30 (3 regional councils, 26 subordinate water agencies, 1 Federal Authority for Environment and Geology)	39 (2 Directorates for Structure and Authorizations, 36 Lower Water Authorities, State Authority for Environment)	9 (8 Lower Water Authorities, 1 State Authority for Environment)	60 (5 district governments, 54 Lower Water Authorities, 1 Federal Authority for Environment, LANUV)	4 (1 State Office for Water Management, Coastal and Nature Protection, 2 Lower Water Authorities, 1 technical authority	25 (1 Administration Office, 1 Thuringian State Authority for Environment and Geology, 23 Lower Water Authorities)	6 Départements	1 Water management authority	Public authority of Wallonia – Agriculture, Natural resources, Environment (W-BE) Avenue Prince de Liège 15 B - 5100 Namur (Jambes)	10 provinces and 15 water boards and 20 regions and municipalities

1) In the Netherlands, the competencies for the regional waters have been delegated to the Provinces and Water Boards.

Annex 3 - Information on the coordination of the targets of flood risk management in the IRBD Rhine

Based on the general strategic target set in Article 7, Paragraph 2 of the FD, the States in the IRBD Rhine have set out the following national or regional targets. The evaluation by the ICPR shows that, with respect to flood risk management, the general targets of the overriding IFRMP for the IRBD Rhine and the national or regional targets of states, Länder or regions in the IRBD Rhine correspond.

The national and regional targets are materialized in the FRMPs of the states and regions in the IRBD Rhine and partly in further new targets. Generally, a distinction can be made between the following approaches:

- In **Switzerland** the targets are generally related to the handling of gravitational natural hazards (water hazards, landslides, gravitational processes and avalanches). There is no particular planning targeted at the FD.
- In **Liechtenstein**, the targets generally concern the approach to floods. There is no particular planning targeted at the FD.
- In **Austria** the overarching targets are put into concrete terms by subordinate targets related to measures. This approach takes into account 36 (types of) measures.
- In **Germany**, the Bund/Länder-Arbeitsgemeinschaft Wasser puts the targets into concrete terms in sub-targets. For the first time, the German federal states have drafted for the 2nd cycle a common Flood Risk Management Plan for the entire German Rhine river basin. Thus there is an even more close coordination of the flood risk management within the German Rhine River Basin Community (Flussgebietsgemeinschaft Rhein). The targets and sub-targets are presented in the common FRMP of the German federal states for the Rhine catchment and progress in achieving the goal is assessed. The targets continue to be underpinned by measures from the nationwide LAWA-BLANO catalogue of measures. The jointly defined targets apply to all areas at risk in the different river basin districts.
- In **France**, the national objectives set out in the SNGRI (national flood risk management strategy) are translated into objectives and complemented in the flood risk management plans (FRMPs) and are:
    - specific to the river basins. For the Rhine-Meuse basin, the five objectives (supporting cooperation between stakeholders, improving knowledge and developing the risk culture, sustainable land use planning, risk prevention through balanced and sustainable management of water resources, crisis preparedness and encouraging a return to normal)
    - specific to areas with significant flood risk (TRI). With these objectives, the objectives at the basin level are fixed for specific areas.

  All objectives are fixed after consultation with stakeholders of flood risk management. The measures of the FRMP are directly linked to the objectives and largely cover all aspects of flood risk management. As far as the TRI are concerned, local flood risk management strategies supported by local authorities define the measures in connection with the specific objectives of the TRI.
- In **Wallonia**, technical committees have defined specific targets per sub-basin in addition to the overall targets applicable to the entire region. These take into account regional specificities (heavily populated sub basins or increased danger of mudslides, heterogeneous sub basin ...).
- In **Luxembourg**, the flood risk management plan sets the objectives for the whole country. These apply both to areas with and without a significant flood risk. From these objectives, types of measures are derived, which lead to concrete measures within the risk areas. Furthermore, there are strategic or conceptual measures for the whole country.
- In the **Netherlands**, three general targets have been fixed, as well as specific targets for the four areas presenting a potentially significant flood risk in the Dutch part of the IRBD Rhine.

Note: *National/regional FRMPs in the IRBD Rhine and corresponding links are indicated in Annex 4.*

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 secured 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:

- Internationale Regierungskommission Alpenrhein (IRKA) (AT, CH, FL)
- Internationale Rheinregulierung (IRR) der gemeinsamen Rheinkommission (GRK) (AT, CH)
- Koordinierungsgruppe (Alpenrhein/Bodensee) der Internationale Gewässerschutzkommission für den Bodensee (IGKB) (AT, DE, CH, FL)
- Ständige Kommission für den Ausbau des Oberrheins zwischen Straßburg / Kehl und Lauterbourg / Neuburgweier (The A-Committee is in charge of the sections upstream of Strasbourg) (FR, DE)
- Working group flood protection and hydrology (IH) of the International Commissions for the Protection of the Moselle and Saar (ICPMS) (FR, DE, LU, Region Wallonia (BE)); Link to the **Flood Risk Management Plan of the IRBD Moselle-Saar** (International Commissions for the Protection of the Moselle and Saar (ICPMS): http://www.iksms-cipms.org/servlet/is/2002120/ (German) and http://www.iksms-cipms.org/servlet/is/2002121/ (French).
- Permanent German-Dutch transborder river commission (DE, NL)
- German-Dutch Working Group Floods (DE, NL)
- International Working Group / Steering Group Delta Rhine (AGDR/SGDR) (DE, NL)

Annex 4 – Survey of national/regional flood risk management plans in the IRBD Rhine and corresponding links

Note: This Annex shortly presents the national or regional detailed FRMPs in the IRBD Rhine. Links refer to the plans.
The list of links is also published here: https://www.iksr.org/en/eu-directives/floods-directive/flood-risk-management-plan/national-reports

Switzerland

National background for dealing with risks due to natural hazards in Switzerland

Strategy

The Natural Hazards Strategy existing since 2003 was updated in 2018 by the National Platform for Natural Hazards (PLANAT). The strategy "Management of risks from natural hazards - Strategy 2018" defines targets when handling risks arising from natural hazards and explains, according to which principles these are to be achieved. Proven elements are continued and further developed, as e.g. the approach of integrated risk management. The Swiss Federal Council has taken note of the Strategy 2018 as presented on 4 July 2018.

The Strategy 2018 recommends the following priorities when dealing with risks from natural hazards:

- Establish a comparable management of risks
- Establish an integrated risk management at all levels
- Avoid new, unacceptable risks
- Establish competencies
- Create an awareness for responsibilities
- Extend and exchange knowledge
- Enhance solidarity

Action Plan

Parallel to the update of the strategy, a comprehensive and broadly based assessment of the situation regarding the management of natural hazards in Switzerland was prepared in the form of the report "Dealing with natural hazards in Switzerland", which was approved by the Swiss Federal Council in 2016. The report analyses the situation of natural hazards in Switzerland, points out the need for action and proposes improvement measures. The report indicates 67 measures in five fields of action:

- Hazard and risk fundamentals
- Preparedness
- Coping and regenerating
- Risk communication, education and research
- Overall planning and cooperation

Due to the close coordination with the updating of the Strategy 2018, the report "Dealing with natural hazards in Switzerland" corresponds to the "Action Plan" concerning the updated strategy.

State of implementation

The planning stipulates that the measures of the report "Dealing with natural hazards in Switzerland" will be implemented by 2040. By mid-2020 the state of implementation represents well 20 %, whereas the implementation of the fields of action "Hazard and risk fundamentals" and "Coping and regenerating" is slightly more advanced.

Links:

- Strategy "Dealing with natural hazards in Switzerland - Strategy 2018" www.planat.ch *(more information in English here: https://www.bafu.admin.ch/bafu/en/home/topics/natural-hazards/info-specialists/risk-management/where-are-we-today.html)*
- Report of the Federal Council "Dealing with natural hazards in Switzerland" 2016 https://www.bafu.admin.ch/bafu/de/home/themen/naturgefahren/dossiers/naturgefahren-sicherheit.html

- Targets and Focal Points of Action of the Federal Office for the Environment FOEN when dealing with natural hazards of 2011: https://www.bafu.admin.ch/bafu/en/home/topics/natural-hazards/publications-studies/publications/living-with-natural-hazards.html

Planning, implementation and financing

Planning, implementation and financing of flood protection measures are regulated by
- the Federal Law of 21 June 1991 on hydraulic engineering
http://www.admin.ch/opc/de/classified-compilation/19910136/index.html
- the corresponding regulation of 2 November 1994 on hydraulic engineering (Regulation on Hydraulic Engineering/Wasserbauverordnung, WBV)
http://www.admin.ch/opc/de/classified-compilation/19940305/index.html
- the guidance Flood control at rivers and streams:
https://www.bafu.admin.ch/bafu/en/home/topics/natural-hazards/publications-studies/publications/flood-control-at-rivers-and-streams.html
- the manual Programme Agreements concerning the Environment
https://www.bafu.admin.ch/bafu/de/home/themen/recht/publikationen-studien/publikationen/handbuch-programmvereinbarungen-im-umweltbereich-2020-2024.html

Within supra-cantonal major projects development concepts fulfil a function comparable that of the EU Management Plans. Examples:
- ***Alpine Rhine***: Development Concept Alpine Rhine
https://www.alpenrhein.net/Projekte/Generationen-Projekt
- ***Thur:*** The Thur - A River with a Future for Man, Nature and Landscape. Targets for hydraulic engineering, 2001
In 2001 the Thur-cantons agreed on common aims for hydraulic engineering on mount Säntis. This so-called "Säntis-Charta" is the basis for common, coordinated action of all five cantons concerned and of the federal state in order to achieve a lively future of the Thur for man, nature and landscape.

Liechtenstein

When dealing with risks due to natural hazards, Liechtenstein primarily adopts the Swiss strategy. As far as permitted by the legal basis, this also applies to targets and principles of integrated risk management.

Link:
Information at: info.abs@llv.li
http://geodaten.llv.li/geoportal/naturgefahren.html
https://www.llv.li/#/12004/naturgefahren

Austria

In Austria, the three steps of implementing the EU Floods Directive (preliminary risk assessment, flood hazard maps and flood risk maps, flood risk management plan) are coordinated with all relevant sectors. This process mainly involves representatives of the Federal Ministry of Agriculture, Regions and Tourism as the responsible body with the Federal Ministry for Climate Protection, Environment, Energy, Mobility, Innovation and Technology, the Federal Ministry of the Interior (responsible for state crisis and disaster control management), the specialist departments Federal Water Engineering Administration, Torrent and Avalanche Control, Federal Waterways Administration, Water Management Planning, Spatial Planning, Building Regulations and Civil Protection, the Federal Office for Water Management, the Viadonau, the Federal Environment Agency and the Austrian Spatial Planning Conference. In regularly staged events, NGO and stakeholders are integrated into the procedure. It is thus made sure that the important parts of the flood risk cycle are being taken into account. All steps are prepared within a multi-stage procedure, thus granting that relevant foundations and data and the inclusion of relevant sectors are taken into account.

After completion of the 1st implementation cycle of the EU Floods Directive with the report to the European Commission (22.03.2016), evaluations of the work steps were carried out at several levels and by various institutions. The evaluation, formulation of recommendations and presentation of empirical values is aimed at reviewing the

implementation steps to be worked out and adjusting them if necessary. The adaptation and further development of the Austrian Flood Risk Management Plan takes into account the main recommendations relevant for Austria. These recommendations were formulated by the European Commission, the European Court of Auditors and external evaluations at national level. In addition, empirical values from the federal states and the federal government were incorporated. Ideas and proposed solutions were also discussed and partly taken into account by the flood working group of the Common Implementation Strategy (European Commission and Member States) and the International Commissions for the Protection of the Danube, Rhine and Elbe in workshops and meetings.

Significant changes to the Flood Risk Management Plan 2021 (https://www.bmlrt.gv.at/wasser/wisa/hochwasserrisiko.html) compared to the 2015 flood risk management plan relate to:

- The appropriate objectives have been simplified and adapted.
  - Avoid new risks
  - Reduce existing risks
  - Improve preparedness and coping capacity
  - Increase awareness of risks and dangers
- Specific objectives have been assigned to all types of measures in order to better evaluate the achievement of objectives.
- The catalogue of measures of the FRMP2015 was revised on the basis of the experience values from the 1st cycle. Where necessary and appropriate, measures were divided into "planning" and "implementation".
- As part of the catalogue of measures, those measures of the National Water Management Plan 2021 with relevance to flood risk management were also presented.
- The programmes of measures at level of the potentially significant flood risk areas (APSFR) have been made clearer and simpler/understandable (a 4-page brochure with the main contents has been sent to all municipalities in APSFR) in order to make them more accessible to the potentially affected population.
- Measures with a "periodic implementation" which mainly result from a legal obligation will be replaced by general, descriptive chapters of FRMP2021 and will no longer be queried at APSFR level.
- It is also shown how the measure can contribute to the Climate Change Adaptation Strategy under the Action Programme. The action programme can be found at https://www.bmk.gv.at/themen/klima_umwelt/klimaschutz/nat_klimapolitik/anpassungsstrategie.html or https://www.bmlrt.gv.at/wasser/wasser-oesterreich/herausforderungen/klimawasser.html

Link:
https://www.bmlrt.gv.at/wasser/wisa/hochwasserrisiko.html

Germany

Summary of the Joint FRMP for the Rhine 2021-2027 for the German part of the Rhine basin

The joint FRMP for the Rhine 2021-2027 is an update of the 26 individual FRMPs drawn up by the Länder in the German part of the Rhine catchment area for the 2015-2021 period. In response to the evaluation of the first FRMPs by the European Commission and the statement contained therein regarding the large number of German plans on the Rhine, it was decided for all river basin districts in Germany to implement the updating of the FRMPs in each river basin district in the form of a single, jointly prepared FRMP. The preparation of the joint document FRMP for the Rhine 2021-2027 takes place in a working group in which all Länder having a share in the river basin are represented and is coordinated by the agency of the River Basin Community Rhine. The plan is based on nationally agreed model texts of the Federal/Länder Working Group on Water (LAWA) for all FRMPs to be prepared that claim to meet the requirements of the EC FD. The model texts are supplemented by river basin-specific information.

The central component of the joint FRMP for the Rhine 2021-2027 is the updating of the planning of measures, including the presentation of progress in achieving the objectives. The basis for this is the relevant information from the Länder concerned. In the joint FRMP, documentation is carried out in aggregated form at the level of the study areas and on the basis of LAWA's standardised nationwide catalogue of measures.

The Länder are also preparing background documents in which concrete measures can be addressed.

In the first cycle of the FD, each of the Länder drew up FRMPs for their own territory, possibly for different territorial units. These FRMPs present the objectives and measures for the respective river basin. Within the framework of LAWA, the following basic objectives for FRM have been set in Germany:

- Avoid new, risks (before a flood event) in the area at risk
- Reduce existing risks (before a flood event) in the area at risk
- Reduce adverse consequences during a flood event,
- Reduce adverse consequences after a flood event.

These fundamental overall objectives serve to prevent and reduce the adverse consequences of flooding for all four protected assets (human health, environment, cultural heritage, economic activities). They cover the four EU aspects (prevention, protection, preparedness and restoration/regeneration).

LAWA has developed its own methodology for assessing the progress made in achieving the objectives. In this methodology, the progress of the implementation of the measures is assessed and qualitatively described. In addition, the quantitative results from the tool "FloRiAn" of ICPR EG HIRI for the assessment of the risk along the main stream will be taken into account in the plan.

In the 2nd cycle of the FD, the Länder in the German part of the Rhine catchment area prepare a joint FRMP. The four objectives of the 1st cycle were specified in further objectives for the 2nd cycle in Germany within the framework of LAWA. The aim here is to make the achievement of these objectives more measurable and, based on this, to present progress towards the achievement of the overall objectives in a more differentiated manner.

The international coordination of flood risk management in the Rhine basin is explained in the introductory chapter of the National FRMP for the Rhine 2021-2027.

A general chapter in the Rhine FRMP 2021-2027 is devoted to climate change, supplemented by a chapter on the specific effects of climate change on the Rhine basin. The planning of measures also refers to the transnational cooperation project "Climate change and consequences for water management" (KLIWA). Furthermore, the effects of the measures on climate change are indicated in the LAWA-BLANO catalogue of measures.

The FRMP for the German part of the Rhine basin contains a chapter on coordinating the implementation of the WFD and the FD. Furthermore, the LAWA-BLANO catalogue of measures indicates possible synergies or conflicts between the measures of the two Directives.

Links: River Basin Community Rhine (Flussgebietsgemeinschaft Rhein - FGG Rhein): http://fgg-rhein.de/servlet/is/87720/

More links:
- https://geoportal.bafg.de/karten/HWRM/
- http://www.hochwasserzentralen.de
- https://www.bmu.de/download/nationales-hochwasserschutzprogramm/
- https://www.kliwa.de/hydrologie.htm

France

1. General description of the plan(s)

The FRMP 2022-2027 is divided into four parts. Some of its annexes (environmental assessment, balance of the presentation of the preliminary summary of major issues to the public, etc.) have been hived off. The FRMP and its annexes can be downloaded from the DREAL Grand Est website
The FRMP covers all aspects of flood risk management, with the emphasis on prevention, protection and preparedness. In particular, it takes into account the costs and benefits, extent of flooding, areas with flood retention potential, environmental objectives set out in the WFD, land use and water management, spatial planning, land use and nature conservation.
The FRMP supports sustainable land use practices, the improvement of water retention and controlled flooding of certain areas in the event of a flood event.

2. Information on the implementation of the first national FRMPs and their objectives and measures (summary requested)

The main result of the first management cycle is that there is now a strategy for reducing flood-related damage for each significant risk area (TRI) in the Rhine-Meuse river basin: the local flood risk management strategy (SLGRI).
For certain significant risk areas located in the same river basin, the same local strategy applies, which defines the measures of the FRMP on a territorial basis. Their operational implementation takes place in action plans for flood prevention (PAPI).
The following table shows the supporting structures of the local flood risk management strategy in the Rhine river basin district and the significant risk areas within its scope

Local flood risk management strategy	Significant risk area(s) concerned	Supporting structure ***Management*** (*if applicable*)
Lower Moselle	Significant area at risk Metz Thionville Pont-à-Mousson	Syndicat Mixte (administration union) Moselle Aval
Saar catchment area	Significant area at risk Saargemünd	Communauté d'Agglomération Sarreguemines Confluence *Management: Syndicat des Eaux et de l'Assainissement Alsace-Moselle (SDEA)*
Meurthe and Madon catchment areas	Significant area at risk Nancy Damelevières Significant area at risk Saint-Dié Baccarat Significant area at risk Pont-Saint-Vincent	EPTB Meurthe et Madon
Épinal	Significant area at risk Épinal	Communauté d'Agglomération d'Épinal
Bruche Mossig Ill Rhine	Significant area at risk Greater Strasbourg	Overall coordination: Strasbourg Eurométropole *Management: Region Grand Est (main stream Ill), public authorities (main stream Rhine), Syndicat Mixte du Bassin Bruche Mossig (main stream Bruche)*
Ill upstream Doller Largue	Significant area at risk Greater Mulhouse	Conseil Départemental du Haut-Rhin *Management: Syndicat des Rivières de Haute Alsace (or Syndicat Mixte du Bassin de l'Ill)*

3. New objectives and measures for the second national FRMP(s) for the period 2022-2027

The update of the FRMP consolidates the measures contained in the FRMP 2016-2021 and takes account of regulatory and technical developments since the adoption of the previous FRMP.
The FRMP has been brought in line with the Decree "Flood risk prevention plan" (Plan de Prévention des Risques inondation (PPRi)) of 5 July 2019 and adapted to incorporate the broad principles in its objectives and provisions, so that the general principles of this decree are applied uniformly throughout the territory and in particular where no PPRi exist.
Aspects of climate change have been integrated into the plan (p. 5).
As provided for in the FD, the arrangements for monitoring and evaluating progress have been included in the FRMP. Evaluation indicators measure the achievement of the most structuring objectives of the flood risk management policy in the Rhine-Meuse river basin for the period 2022-2027, to which target values and deadlines apply.

4. Possible linking of the national plans with the FRMP of IRBD Rhine or the plans of the sub-basin areas (e.g. Moselle-Saar, Lake Constance, Rhine delta) or integration of the national plans into the FRMP

Objective 1.3 of Part A.1.1 of the French FRMP for the Rhine involves the coordination of measures with cross-border effects in the Rhine and Meuse river basin districts. Information is exchanged in the working groups of the international commissions.
The French FRMP refers to the IFRMP.

5. Brief information on the consideration of climate change and adaptation to climate change in the 2nd national FRMPs

The FRMP 2022-2027 emphasises the link between flood risk and climate change. It recalls the impact on flood risk at the current state of knowledge. As flood risk prevention contributes to adaptation to climate change, the pursuit of the FRM objectives with measures implemented today will better prepare areas for the hazards of tomorrow.
The following principles were systematically incorporated into the FRMP:

- detect mismatches by identifying and avoiding "erroneous good ideas";
- give preference to "no regret" measures that are beneficial regardless of the extent of climate change
- give preference to multifunctional measures and integrated projects, as well as to measures which have multiple benefits and thus make it possible to find solutions to different problems simultaneously;
- seek resource-saving solutions (water, soil, fossil fuels)
- equal distribution of resources and solidarity among users, while respecting the environment.

6. Brief information on the link(s) between the 2nd national FRMPs and the 3rd national water management plans (WFD)

In order to exploit the synergies and mutual benefits of the Directives and integrate them into the achievement of the environmental objectives set out in the Water Framework Directive, the updating of the objectives and provisions of the FRMP for the period 2022-2027 was coordinated with those of the lead water management project "Schéma directeur d'aménagement et de gestion des eaux" (SDAGE) (WFD management plan).
Given the mutual benefits of flood risk management, water management and the management of the aquatic environment, a synergy of methods and content between the FRMP and the SDAGE has been sought in the Rhine-Meuse river basin in order to achieve integrated river basin management. The measures in the FRMP relating to cooperation between stakeholders (Objective 1) and flood risk prevention through balanced and sustainable management of water resources (Objective 4) also apply to the Rhine-Meuse SDAGE.

Link: http://www.grand-est.developpement-durable.gouv.fr/bassin-rhin-meuse-r6723.html

Luxembourg

In Luxembourg, the FRMP will be revised in the second cycle of the implementation of the FD according to the EU requirements of this cycle (review and adapt if necessary) and the findings from the first two steps, i. e. the preliminary flood risk assessment and the preparation of flood hazard and risk maps.
The revision is preceded by the completion of a number of important studies, which are intended to concretise the flood risk and to better research the hydraulic/hydrological effects within the sub-catchments on Luxembourg territory.
On the basis of all these findings, the catalogue of measures is also to be reviewed, adapted and supplemented. It will be updated and unimplemented measures are examined with regard to their effect on reducing flood risk within the risk areas.
Furthermore, possibilities are to be worked out to be able to better check the achievement of the defined goals in the future.

Link: https://eau.gouvernement.lu/fr/administration/directives/directiveinondation/2ieme-cycle/ProjektDesZweitenHochwasserrisikomanagementplans.html

Belgium (Wallonia)

The document "Flood risk management plan in Wallonia for the 4 river basin districts of Wallonia - update 2022 - 2027" contains the update of the 1st cycle FRMPs for the international river basin districts to which Wallonia belongs. The plans of the 4 IRBD have thus been brought together in a single document.
Once approved by the Walloon Government, they will replace the FRMPs 2016-2021.

After an introductory description of the international river basin districts and sub-basins, Chapter 1 summarises the preliminary flood risk assessment, which was carried out for the first time under this cycle. The main conclusion of this preliminary assessment is that there is a significant potential flood risk for the whole territory of Wallonia.
Chapter 2 presents the methodology for the preparation of flood hazard and risk maps. The maps and the associated protected assets were analysed in detail.
In Chapter 3, progress from the first plans is assessed using time and financial indicators.

Chapter 4 defines the overall objectives and the specific objectives for the second cycle. The overall objectives are defined as follows:
1. Improved knowledge on flood risk
2. Reduction and delay of surface runoff in river catchments;
3. Developing riverbeds and floodplains while preserving and promoting natural habitats that provide stability;
4. Reducing vulnerability to flooding in flood-prone areas;
5. improving crisis management in the event of flooding.
6. Reducing the burden of damage on society

The specific objectives relate to each sub-basin. They have been established in consultation with the technical committees of each sub-basin (Comités Techniques par Sous-Bassin Hydrographique - CTSBH). Two specific objectives apply to each phase of the flood management cycle. This method made it possible to consider the phases of the management cycle other than just protection.

The methodology for preparing the 2022-2027 plans is presented in Chapter 5. In Wallonia, the preparation of FRMPs is based on a central consultation body of the main actors in flood risk management: the Technical Committees per sub-basin (CTSBH). These working groups meet about once a year to monitor the implementation of the 1st cycle and to define new objectives and projects for the following cycle. Consultation and coordination of this network of actors from different fields (spatial planning, emergency services, river management, etc.) represent a core element in the process of developing this second cycle.

Thanks to this method and a comprehensive survey, 814 new projects have been proposed, discussed and validated at the CTSBH to reduce the flood risk associated with river and surface runoff. These will be linked to some forty overall measures affecting the whole of Wallonia.

Chapter 6 summarises the information from the public consultation.

Finally, Chapter 7 presents the studies that can be used to take better account of climate change in the next cycle.

Link: https://inondations.wallonie.be

The Netherlands

Summary of the Dutch flood risk management plans

For the last programming period (2016-2021), the Netherlands had established four separate flood risk management plans for the Dutch part of the international river basin districts of the Rhine, Meuse, Ems and Scheldt. These plans have been updated for the period 2022-2027 and combined into one document. It sets out objectives and measures for the designated areas with potential significant flood risks. In some cases, the Netherlands have opted for different objectives and measures than in the first plans.

Area	Objectives	Measures	
General (all designated areas)	The Netherlands are prepared for future developments.	• Create and execute a delta programme annually • Reassess delta decisions and preferential strategies every six years • Implement the knowledge programme on sea-level rise • Develop an integrated river management programme • Update KNMI climate scenarios	
	In 2050 the Netherlands will be climate-resilient and flood-adapted	• Implementing the Deltaplan spatial planning adaptation • Strengthen, extend and adapt watercourse assessment	
	The Netherlands are prepared to take appropriate action in case of (imminent) flooding.	• Keep contingency and emergency plans up to date • Early warning of impending flooding • Education, training and practice • Promoting awareness of water and shared responsibility • Improve knowledge and cooperation	
Area A	Limit significant damage locally.	• Establish local standards and rules to limit substantial flood-related damage • Inform users of area A about flood risks	
Area B	The probability of dying from flooding is less than 1/100,000 per year by 2050 at the latest (basic protection level).	• Assessing the condition of primary protection systems • Evaluating standards for primary protection systems • Putting primary protection systems in order • Maintain primary protection systems • Maintain the discharge and absorption capacity of large rivers • Lower flood levels of large rivers • Maintain the coastal foundation • Making space available in the long term	
Area C	The regional protection structures protecting area C will meet the standards by 2050 at the latest (or an earlier date set by the province concerned).	• Evaluate and reassess the designation and standardisation of regional protection systems • Assess the condition of regional protection systems • Put regional protection systems in order • Maintain regional protection systems • Maintain the discharge and absorption capacity of regional waters and manage water levels	
	The protection systems along the state canals will meet the state-defined standard by 2032 at the latest.	• Designate and standardise protection systems along state canals • Assess the condition of the protection systems along the state canals • Fix protection systems along state canals • Maintain protection systems along state canals	
Area D1	In D1 areas along Linge, Roer, Gulp, Geul and Geleenbeek, flood risks will be limited as far as possible during the planning period. For Roer, Gulp, Geul and Geleenbeek, the objective of meeting the established standards by 2035 at the latest also applies.	Linge: • Examine flood risks in the non-protected area along the Linge • Maintain the water retention capacity of the Linge	Roer, Geul, Gulp, Geleenbeek: • Test flood risks against the standard • Take material measures • Protect brook valleys

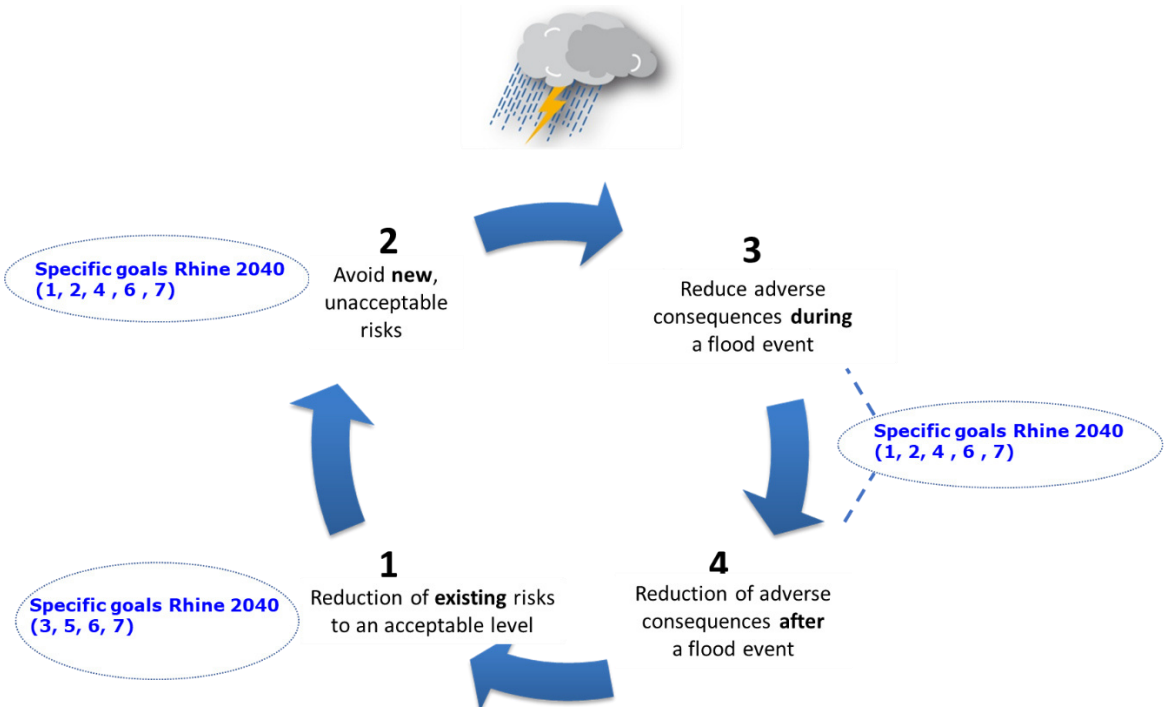
Three objectives and related measures cover all areas with potentially significant flood risks. The other objectives and related measures relate to one of the four types of designated areas with potential significant flood risks, areas A, B, C or D1. In the Dutch part of the international river basin district of the Rhine, all four types of designated areas occur. Areas A and B may be flooded by the main Rhine river, the Rhine arms, the IJsselmeer and coastal waters. Area A is not protected against such flooding, while area B is. Areas C and D1 may be flooded by regional waters. Area C is protected against flooding of regional waters, area D1 is not.

Certain transboundary regional waters in the Dutch part of the international river basin district of the Rhine do not present a potentially significant flood risk but have been identified to facilitate transboundary coordination. These areas (designated as type D2) are located along seven non-diked regional waters, i.e. the Oude IJssel, Aastrang, Boven Slinge, Beurzebeek, Berkel, Buursebeek and Dinkel.

Map:
Four types of areas designated in the Dutch part of the international river basin districts of the Rhine, Meuse, Ems and Scheldt (based on the designation in 2018)

Link: https://www.helpdeskwater.nl/onderwerpen/wetgeving-beleid/europese-richtlijn-overstromingsrisico/overstromingsrisicobeheerplannen/

Annex 5 - Objectives and measures of the programme "Rhine 2040" and link to the IFRMP



Relationship between the 4 targets of the IFRMP for the period 2022-2027 and the 7 specific goals until 2040 of the "Rhine 2040" programme

Note: *See Annex 8 for a detailed overview of the correspondence between the objectives and measures of the 2nd IFRMP and "Rhine 2040"*

RHINE 2040

General objective:

The flood risks are reduced by at least 15% on the Rhine and its tributaries by 2040 in comparison to 2020, through an optimal combination of measures.

7 specific goals for 2040 and the measures to be taken:

(1) The flood information, forecast and warning systems are up to date and adequate training is undertaken. The nations support each other in the event of a flood.

Measures:

1. Continuous improvement of flood information, forecasting and warning on the basis of current/new knowledge as a permanent task of flood risk management;

2. Future exchange of experience with parties in civil protection and crisis management, in the context of comprehensive flood risk management.

(2) The measures to reduce flood levels planned for 2020+ will be implemented by 2030. These represent an effective reduction in flood levels on the Rhine, meaning that the flood risk on the Rhine is significantly reduced.

Measures:

1. Realisation of further water retention measures by 2030; implementation must be accelerated;

2. Keeping free from construction the areas on the Rhine and the tributaries, for the retention areas still to be implemented;

3. Further methodical improvement of knowledge about the risks and effectiveness of different measures of flood risk management, for example with the help of verification instruments like the FloRiAn tool (Flood Risk Analysis); regular reviews of effectiveness every 6 years (2027, 2033 and 2039); recalculation of the effectiveness of planned measures - depending on the availability of data.

(3) Other spaces that go beyond the scope of measures already planned for 2030 are charted, secured by spatial planning and kept free for use, with regard to flood retention on the Rhine and on the tributaries.

Measure:

- *Identification and compilation of other possible areas for further flood retention on the Rhine and Rhine tributaries and/or in the Rhine catchment area, which go beyond the measures to be implemented by 2030.*

(4) Synergies are drawn upon between measures to improve flood protection and to improve the ecological situation on the Rhine and its tributaries.

Measures:

1. Implementation of programmes of measures tailored to individual cases in the relevant nations using the variety of protection and water level-reducing measures, e.g. the creation of retention or "Room for the river" measures, renaturation of rivers and wetlands, especially in the catchment area, reactivation of flood areas, increasing the storage and infiltration capacity of soils (e.g. through extensification of agriculture), nature development, afforestation and promotion of precipitation seepage;

2. Selection of measures using potential synergies with other goals; in so doing, it is important to strike a balance between short-term costs and long-term effects, and to deal with uncertainties regarding the indications of climate change and knowledge of the effects on other objectives or functions of the water.

(5) Undeveloped flood areas are kept free from development.

Measures:

- *In the context of risk-based spatial planning, existing knowledge of the dangers and risks posed by flooding is taken into account.*
- *Basic maintenance of undeveloped floodplains.*

(6) New buildings and, where applicable, also existing buildings in flood-prone areas are adapted to the flood risks (building precautions).

Measures:

1. The examination of property protection measures in the case of existing buildings in flood areas, in particular in the event of changes or renovations within the framework of building approval;

2. The flood-adapted construction of new buildings that cannot be avoided in flood areas;

3. The promotion of the continuous exchange of knowledge between the nations regarding these measures.

(7) Consciousness of flood risks and through this, also personal precautions, are strengthened through information, training and the raising of awareness.

Measures:

1. Improving flood risk communication with the aim of expediting the implementation of non-technical measures (damage prevention, building precautions, natural hazard insurance, etc.), i.e. the focus is on independent action. The ICPR supports these activities with appropriate events;

2. Promotion of an intensive exchange of information, and the involvement of the public in the nations of the Rhine catchment area via the provision of information, advice, training, exercises, prevention in educational, civic and youth projects, round tables and the formation of municipal flood partnerships for the correct, damage-reducing handling of flood events. The ICPR can support these activities.

Annex 6 - Survey of national climate change adaptation strategies in the IRBD Rhine

Switzerland

Adaptation to climate change in Switzerland

Aims, challenges and fields of action. First part of the Federal Council's strategy

Climate change also has an impact on the environment, the economy and society in Switzerland. Measures to adapt to these impacts are already necessary today and will become increasingly important in the future. The Federal Council adopted the first part of its adaptation strategy on 2 March 2012. In this strategy, it formulates goals and principles for adaptation and describes the greatest cross-sectoral challenges in adaptation at federal level.

Action Plan. Second part of the Federal Council's strategy

On 9 April 2014 the Federal Council adopted an action plan for the years 2014 to 2019 as the second part of its adaptation strategy. This action plan summarises 63 adaptation measures taken by the federal offices with the aim of exploiting the opportunities presented by climate change, minimising the risks and increasing the adaptability of society, the economy and the environment.

In summer 2020 a second action plan for the period 2020-2025 will be submitted to the Federal Council for approval. It contains 75 measures by the federal agencies involved with which they will respond to the greatest risks of climate change in Switzerland in the coming years.

Federal Council strategy for adaptation to climate change in Switzerland
https://www.bafu.admin.ch/bafu/en/home/topics/climate/info-specialists/adaptation/strategy.html
Goals, challenges and fields of action. First part of the strategy
https://www.bafu.admin.ch/bafu/en/home/topics/climate/publications-studies/publications/adaptation-climate-change-switzerland-2012.html
Action Plan 2014–2019 Second part of the strategy
https://www.bafu.admin.ch/bafu/de/home/themen/klima/publikationen-studien/publikationen/anpassung-klimawandel-schweiz-2014.html

Pilot programme on adaptation to climate change

The federal government's adaptation strategy also includes the pilot programme "Adaptation to Climate Change". It supports exemplary, innovative projects of the cantons, regions, cities and municipalities and shows how Switzerland can adapt to the changing climate in concrete terms. The projects serve to minimise climate risks on the ground, increase adaptability and exploit opportunities.

During the first phase of the pilot programme (2013 to 2017), 31 projects were implemented throughout Switzerland. The second programme phase started in 2018 with 50 new projects on six themes

- Greater heat stress
- Increasing summer drought (focus on agriculture)
- Increasing flood risk, decreasing slope stability and more frequent mass movements
- Changes in habitats, species composition and landscape (focus on agriculture and forest management)
- Spreading of harmful organisms, diseases and alien species
- Awareness raising, information and coordination

Further information on the pilot programme:
https://www.bafu.admin.ch/bafu/en/home/topics/climate/info-specialists/adaptation/pilot-programme.html
Results of the first phase of the pilot programme
www.nccs.admin.ch/pilotprogramm
(https://www.nccs.admin.ch/nccs/en/home/measures/pak.html)

Liechtenstein

The government adopted the first adaptation strategy in June 2018. This strategy formulates goals and principles for adaptation and describes the cross-sectoral challenges and measures for adaptation to climate change in Liechtenstein; specifically in the sectors of water management, natural hazards, agriculture, forestry, energy, tourism, biodiversity, health and spatial development. The priorities identified can be summarised as follows:

- Ensuring the availability of water for various uses during dry periods
- Flood protection and the associated assessment of the risk situation
- Protecting biodiversity through adequate networking and improvement of ecosystems
- Maintenance and guarantee of the function of the protection forests by means of the greatest possible tree species diversity and regeneration of the populations
- Reduction of heat stress through structural and planning measures.

Adaptation strategy: https://www.llv.li/files/au/anpassungstrategieklimawandel-li.pdf
Further Information -> Fact Sheet Climate with information on climate data in Liechtenstein: https://www.llv.li/files/au/klimafaktenblatt-li-2016.pdf

Austria

In the course of the implementation of the EU Flood Directive and the EU Water Framework Directive in Austria, a comprehensive analysis of the effects of climate change on Austria's water management was carried out by means of the studies "Adaptation strategies to climate change for Austria's water management" commissioned by the Federal Ministry of Agriculture, Regions and Tourism and the Federal Provinces (https://www.bmlrt.gv.at/wasser/wasser-oesterreich/herausforderungen/klimawasser.html). The key messages of these studies regarding developments for floods in the context of climate change are:
Over the last 30 years, floods have increased in about 20% of the catchment areas in Austria, especially in small areas north of the main Alpine ridge. The trends over the last 50 years are less clear. Across Austria, winter floods have increased much more than summer floods. The accumulation of floods in recent decades is within the natural variability of flood decades, but an influence of climate change cannot be excluded.
The results of the studies were incorporated into the Austrian climate change adaptation strategy (https://www.bmk.gv.at/themen/klima_umwelt/klimaschutz/nat_klimapolitik/anpassungsstrategie.html) which focused on the development of flexible and robust recommendations for action that can be adapted to different requirements with little effort and expense, and which bring secondary benefits ("no-regret" and "win-win" measures). Spontaneous maladjustments should be avoided, which, as mere symptom control, are promising in the short term at best, but would prove counterproductive in the long term.

Germany

The general inclusion of climate change in the consideration of FRM is supplemented in Baden-Württemberg, Bavaria, Rhineland-Palatinate and Hesse, together with the German Weather Service, by the transnational cooperation project "Climate change and consequences for water management" (KLIWA — https://www.kliwa.de/). The objectives of the medium to long-term programme are to identify past changes in the water balance, assess future impacts of possible climate changes on the water balance and develop sustainable action plans. In this way, the participating Länder create technical bases and information on future flood events that are relevant for all fields of action of FRM.

Within the framework of the German Adaptation Strategy to Climate Change (Deutsche Anpassungsstrategie an den Klimawandel - DAS) of the Federal Government, which was adopted in 2008, the current state of knowledge on expected climate changes (worldwide and for Germany) and on the associated possible impacts is presented. In addition, possible climate impacts and options for action are outlined for 15 fields of intervention and selected regions. The long-term goal of the DAS is to reduce the vulnerability of

natural, social and economic systems to climate impacts and at the same time to increase the adaptive capacity of these systems and the exploitation of possible opportunities. This also includes the impacts on the water balance or water management, e.g. due to extreme events. To date, two monitoring reports, two progress reports and the Adaptation Action Plan III are available. In addition, funding programmes have been launched and a Climate Adaptation Centre (Zentrum KlimaAnpassung) has been established to advise municipalities and social institutions.
https://www.bmu.de/themen/klimaschutz-anpassung/klimaanpassung

France

In the Rhine-Meuse river basin, climate change may lead to considerably more frequent and more intense extreme events (floods, low water, etc.), permanently alter certain situations and lead to tense situations on a quantitative level.

In the light of these findings, the Comité de Bassin adopted the adaptation and mitigation plan for water resources in the Rhine-Meuse basin in February 2018. Adaptation and mitigation are presented as two inseparable responses to climate-related urgency, as two battles to be fought simultaneously.

In other words, in order to meet the challenge of climate change effectively, it is essential that the solution to the concept of development and management of water resources takes into account the coming climate change and does not contribute to exacerbating global warming, but rather to limiting its extent.

Adaptation is based on two complementary, inseparable pillars: resilience[39] to extreme events and anticipation of "slow" changes, which are linked to better knowledge of the sensitivity of areas and systems to climate change.

In this context, the following principles apply to the design of measures in favour of water and climate:

- Detect mismatches[40] by identifying and avoiding "erroneous good ideas";
- Give preference to "no regret" measures that are beneficial regardless of the extent of climate change
- Give preference to multifunctional measures and integrated projects, as well as to measures which have multiple benefits and thus make it possible to find solutions to different problems simultaneously;
- Seek resource-saving solutions (water, soil, fossil fuels)
- Equal distribution of resources and solidarity among users, while respecting the environment.

These principles have been systematically incorporated throughout the FRMP to achieve "CLIMAT'EAU compatible" (climate and water compatible) areas.

Luxembourg

In Luxembourg, the climate adaptation strategy is defined by the document Strategy and Action Plan for Adaptation to Climate Change in Luxembourg (2018-2023). This document describes the impact of climate change on the Grand Duchy of Luxembourg and the approach to finding appropriate measures. The climate impacts are analysed for different sectors. Furthermore, existing strategies (e. g. flood risk management, nature conservation) are integrated here and concrete measures of these strategies are adopted.
https://environnement.public.lu/fr/klima-an-energie/changement-climatique.html
https://environnement.public.lu/content/dam/environnement/documents/klima_an_energie/Anpassungsstrategie-Klimawandel-Clean.pdf

[39] Refers to the capacity of a social group and/or an area to cope with a disaster, but also the ability to recover from such an event.
[40] Is a situation in which sensitivity to climatic risks is paradoxically increased. Among other things, it is about measures that lead to a shift of sensitivity to other areas, other actors, other times, reduce the future adjustment margin (no flexibility of the measure: dike construction, urban development), increase greenhouse gas emissions or affect water resources.

Belgium (Wallonia)

Several studies have been carried out in Belgium and Wallonia to adapt global climate models at national and regional level (Cordex.be), to estimate the potential costs associated with these climate changes (Evaluation of the socio-economic impact of climate change in Belgium) and to propose adaptation solutions to meet these changes(Adapt).

For further information see:
http://cordex.meteo.be/meteo/view/en/19292661-+Cordex.be.html
https://www.adapt2climate.be/etude-evaluation-des-impacts-socio-economiques-des-changements-climatiques-en-belgique/
http://leswallonssadaptent.be/informations-generales/

The Netherlands

General remark: In general, all projects of the (Dutch) Flood Protection Programme (= programme to reinforce dikes in the Netherlands to meet the new flood protection standards in 2050) take into account the longer-term expected rise in water levels due to climate change.

Strategy

- Ambition: In 2050 the Netherlands will be climate-resilient and flood-adapted. Provided that this is achievable to an acceptable extent, (new) developments will avoid an increase in the risk of damage and victims due to flooding or extreme weather conditions.
- The National Climate Adaptation Strategy (NAS) was adopted in 2016. This strategy presents the impacts of climate change for 9 areas: Water and Space; Nature; Agriculture, Horticulture and Fisheries; Health; Leisure and Tourism; Infrastructure (Road, Rail, Water and Aviation); Energy; IT and Telecommunications; Security.

Task

- As a densely populated and mostly low-lying country, the Netherlands are vulnerable to the effects of climate change.
- Adaptation to climate change affects many policies and sectors, both public and private.
- Measures vary considerably per policy area, sector or area.
- It is a large and lengthy task involving many actors and requiring cooperation.

Consequences of climate change

- Floods; extreme rainfall is becoming more frequent and causing more damage to buildings, agriculture and the transport sector.
- Drought; dry periods are more frequent, last longer and affect biodiversity, agriculture, nature, drinking water, shipping, water quality, and cause subsidence and damage to foundations.
- Floods; higher river run-off and rising sea levels increase the likelihood of flooding; need to ensure flood protection through dike strengthening, more room for the river and maintenance of the coast.
- Heat; the likelihood of intense heat with impacts on water quality, infrastructure, biodiversity and health is increasing.

Delta Programme

- Intensive cooperation between the state, local authorities, research institutions and social partners in various sub-programmes:
    - The Delta Programme Protection and Safety from Water works on flood protection.
    - The Delta Programme Freshwater ensures a sustainable freshwater supply.

    - The Delta Programme Spatial Planning Adaptation promotes climate- and flood-adapted design of urban and rural areas.

Delta programme Spatial planning adaptation

- Contains agreements and a joint working process consisting of ambitions, intermediate goals and steps towards climate-resilient and flood-adapted design.
- Climate adaptation becomes an integral part of policy and legislation, management and maintenance and long-term perspectives for urban and rural areas.
- Climate adaptation provides framework conditions for spatial planning, choice of location and land use, as well as for construction methods. Preference is given to climate-friendly measures that lead to greening, including in the allocation of state subsidies in the area of climate adaptation.
- Additional attention is given to national, vital and sensitive functions, such as drinking water supply, the main road network, electricity supply, health care and ICT & telecom.

Measures for the 2022-2027 programming period

- From 2021 onwards, the State will provide funding to speed up spatial planning adjustments.
- The state provides action programmes for nature, agriculture and built-up areas.
- As part of an investigation programme for the period 2021 to 2026, the Planbureau voor de Leefomgeving (Planning Office for Natural Areas) is developing a stable knowledge base and a monitoring system.
- The Royal Netherlands Meteorological Institute will publish new climate scenarios in 2023.
- In 2021 the government develops a new National Climate Change Adaptation Strategy (NAS).

Annex 7- 1 - Retention measures between Basel and Lobith and corresponding volumes (in million m³)

Note: The years (development states) 1995 up to and including 2021 are part of the Flood Action Plan, the years 2014 to 2021 refer to the period of the first IFRMP of IRBD Rhine, and the year 2027 is the target year for the 2nd Flood Action Plan. IFRMP. Location of measures see ICPR-Rhine Atlas.

Rhine km	Area	State/ Land	Location of measure	Type of measure	Operational volume [millions of m³]				
					1995	2005	2014	2021[4]	2027[5]
174 - 226 234 - 291	Upper Rhine	F	Grand Canal d'Alsace and loops	Exceptional operation/manoeuvre operation of the Rhine power plants	45	45	45	45	45
174.6–219		D-BW	Weil-Breisach	Lowering of foreshores/Ford solution				3.6[2]	21.9
224.8		D-BW	Breisach	Retention operation agricultural weir				9.3[6]	9.3
228.4		D-BW	Breisach-Burkheim	Retention polder					6.5
243		D-BW	Wyhl/Weisweil	Retention polder					7.7
260.5		D-BW	Mouth R. Elz	Retention polder					5.3
272		D-BW	Ichenheim-Meißenheim -Ottenheim (IMO)	Retention polder					5.8
276		F	Erstein	Retention polder		7.8	7.8	7.8	7.8
278.4		D-BW	Altenheim	Retention polder	17.6	17.6	17.6	17.6	17.6
290.3		D-BW	Kehl/Strasbourg	Retention operation agricultural weir	37[1]	37	37	37	37
302		D-BW	Freistett	Retention polder					9
317.4		D-BW	Söllingen/Greffern	Retention polder		12	12	12	12
330		F	Moder	Retention polder	5.6	5.6	5.6	5.6	5.6
354.9		D-BW	Bellenkopf	Retention polder					14
357.5		D-RP	Daxlander Au[3]	Summer polder	5.1	5.1	5.1	5.1	5.1
368		D-RP	Wörth/Jockgrim	Dike relocation			4.2	4.2	4.2
				Retention polder			13.8	13.8	13.8
377		D-RP	Hördt	Reserve area					32
381.3		D-BW	Elisabethenwört	Dike relocation					11.9
390		D-RP	Mechtersheim	Retention polder			3.6	3.6	3.6
390.4		D-BW	Rheinschanzinsel	Retention polder				6.2	6.2
392.6		D-RP	Flotzgrün	Retention polder		5	5	5	5
409.9		D-RP	Kollerinsel	Retention polder		6.1	6.1	6.1	6.1
411.5		D-RP	Waldsee/Altrip/Neuhofen	Dike relocation					1.2
				Retention polder					7.8
436		D-RP	Petersau-Bannen	Dike relocation					1.4
439		D-RP	Worms-Mittlerer Busch	Dike relocation			2.1	2.1	2.1
440.2		D-RP	Worms Bürgerweide	Dike relocation		2	2	2	2
467.3		D-RP	Eich-Gimbsheim	Dike relocation		0.4	0.4	0.4	0.4
468.5		D-RP	Eich	Reserve area					27.7
489.9		D-RP	Bodenheim/Laubenheim	Retention polder			6.7	6.7	6.7
517.3		D-RP	Ingelheim	Retention polder			4.5	4.5	4.5
668.5	Lower Rhine	D / NRW	Köln-Langel	Retention polder			4.5	4.5	4.5
705.5		D / NRW	Worringer Bruch	Retention polder				29.5	29.5
707.5		D / NRW	Monheim	Relocation of dike		8	8	8	8
750		D / NRW	Ilvericher Bruch[7]	Retention polder					10[7]
760.5		D / NRW	Mündelheim	Dike relocation				5	5
802		D / NRW	Orsoy	Dike relocation		10	10	10	10
797.5		D / NRW	Orsoy	Retention polder				19	19
818.5		D / NRW	Bislicher Insel[3]	Dike relocation	50	50	50	50	50
832.5		D / NRW	Lohrwardt	Retention polder				26.3	26.3
850		D / NRW	Bylerward[7]	Retention polder					36[7]
Total retention volume of water level reduction measures on the Rhine per state of development					***160,3*** [1]	***211.6***	***251***	***349.9***	***544.5***

[1] Agricultural weir Kehl: until 2002 13 million m³ are regularly available, further 24 million m³ are available in exceptional cases.

[2] 3.6 millions of m3 = Section 1 of a total of 4 sections. In addition, parts of sections III and IV were completed in 2020.

[3] The Daxlander Au and the Bislicher Insel were already flood plains during Rhine floods before the completion of the measures.

[4] A figure in the 2021 column does not always correspond to the completion of the measure. In any case, the approval procedures have started.

[5] or development status 2020+ = after 2020 (according to planning until about 2027/2030 or as replacement sites)

[6] Full retention volume (9.3 million m3) only operational after completion of protection measures on french side.

[7] Remarks NRW: Polder Ilvericher Bruch and Bylerward are not to be listed as planned water level-reducing measures ready for use by 2027, but the retention areas are to be described as "secured by planning". They are therefore deducted from the total retention volume.

Annex 7-2 - Water level reduction measures on the Delta Rhine downstream of Lobith with minimal requirements regarding the water level reduction to be achieved (in cm)

Note: Measures lowering water levels of the Delta Rhine downstream of Lobith and expected minimum reduction of level (in cm); only the most important measures are listed. The table only lists measures decided according to the planning permission procedure "Room for the River" (2006).

Location of measures see ICPR-Rhine Atlas.

River-km	Area	State	Location of measure	Type of measure	Minimum requirement for water level reduction[1] (for each measure) (cm)				
					1995	2005	2014[2]	2021[3]	2027[4]
865	Bovenrijn/Waal/Merwedes	NL	Rijnwaarden	Lowering of foreshores				11	11
871		NL	Millingerwaard (PKB)	Removal of bottleneck				6	6
871		NL	Millingerwaard (NURG)	Lowering of foreshores					
878		NL	Bemmel	Lowering of foreshores			5	5	5
882		NL	Lent	Dike relocation				34	34
897		NL	Afferdensche and Deestsche Waard	Lowering of foreshores				6	6
887		NL	Midden-Waal	Lowering of groynes			12	12	12
916		NL	Waal Fort St. Andries	Lowering of groynes				9	9
934		NL	Beneden-Waal	Lowering of groynes				6	6
948		NL	Munnikenland	Lowering of foreshores				12	12
955		NL	Avelingen	Lowering of foreshores			11	11	11
964		NL	Noordwaard	Depoldering				30	30
968		NL	Noordwaard (NOP)	Lowering of foreshores			17	17	17
871	Pannerdensch Kanaal, Neder-Rijn, Lek	NL	Huissen	Lowering of foreshores				8	8
883		NL	Meinerswijk	Lowering of foreshores			7	7	7
893		NL	Doorwerthsche Waarden	Lowering of foreshores			3	3	3
898		NL	Renkumse Benedenwaard	Lowering of foreshores			11	11	11
898		NL	Veerstoep Lexkesveer	Removal of bottleneck					
908		NL	middle	Lowering of foreshores			3	3	3
911		NL	De Tollewaard	Lowering of foreshores			3	3	3
917		NL	Machinistenschool Elst	Removal of bottleneck			13	13	13
946		NL	Vianen	Lowering of foreshores				8	8
878	IJssel	NL	Hondsbroekse Pleij	Dike relocation			19	19	19
918		NL	Cortenoever	Dike relocation				31	31
930		NL	Voorster Klei	Dike relocation				26	26
943		NL	Bolwerksplas	Lowering of foreshores				18	18
947		NL	Keizerswaard	Lowering of foreshores				10	10
957		NL	Fortmonder- und Welsumerwaarden	Lowering of foreshores				6 - 8	6 - 8
961		NL	Veessen-Wapenveld	Flood channel				71	71
977		NL	Scheller und Oldenelerwaarden	Lowering of foreshores				9	9
978		NL	Spoorbrug Zwolle	Removal of bottleneck				6	6
980		NL	Westenholte	Dike relocation				14	14
993- 1000.6		NL	IJssel delta phase 1& 2	Summer bed deepening and bypass/flood channel					41[5]

[1] These measures primarily serve to increase the discharge capacity in the Rhine delta. For this reason, only one indication of the desired water level reduction per measure is given. The measures are therefore not included in the total sum of the retention volume.
PKB = Planologische Kernbeslissing (Plan Approval Procedure)
NURG = Nadere Uitwerking Rivierengebied (More detailed development of the river basin)
NOP = Natuurontwikkelingsproject (nature development project)

[2] Flood safety measures operational since 2014 (Source: "31st progress reports for Ruimte voor de Rivier")

[3] Flood safety measures that will be operational by the end of 2020 (Source: "31st progress report Room for the River")

[4] or development status 2020+ = after 2020 (according to planning until about 2030 or as replacement sites)

[5] Planning 2022 (Source: www.ruimtevoorderivierijsseldelta.nl/nl/planning). The "IJsseldelta Phase 2" project (also known as the Reevediep Bypass/River Channel) is scheduled to be operational in 2022

Annex 8 - Survey table concerning the implementation of measures of the 1st IFRMP and determination of new measures for the 2nd IFRMP

Measures of the 1st IFRMP	State of implementation	Continuation of measures or new measures within the 2nd IFRMP (Name of measure within the 2nd IFRMP)	Objectives for the 2nd IFRMP			
			1	2	3	4
4.1 International coordination of measures (including measures of the FRMD with those of the WFD)	Implemented* (permanent task)	**Continuation as general procedure** in chapter 1. Implementation of the FD (Chapter 1.1 and 1.2) and Chapter 4.3.	x	x	x	x
4.2 Improved exchange of information and access to information		**4.1 Improved exchange of information and access to information**				
Improvement of knowledge on the flood risk due to exchange of information (in particular concerning transboundary waters)	Implemented (permanent task)	(1) Improved knowledge on flood risk	x	x	x	
(2) Exchange of information on the development of hydraulic and hydrological as well as climate-related models in the Rhine basin**	Implemented (permanent task)	(2) Exchange on the development of models and contribution to the updating of the climate change adaptation strategy	x	x	x	
(3) Sensitize the population	Implemented (permanent task)	(3) Improve flood awareness	x	x	x	
		(4) Exchange on national building precaution and flood adaptation measures **(NEW)**	x	x	x	
(4) Compilation of international agreements on crisis management in the IRBD Rhine (part A) or at boundary waters including survey over national disaster relief organisations and national aftercare measures	Implemented	(5) Exchange on crisis management and recovery **(NEW)**			x	x
4.3 Improve flood warning and announcement systems		**4.2 Improve flood forecasting and flood warning**				
(1) Availability of a survey over cooperation across countries and Länder in matters of flood announcement systems and flood forecasting systems for the Rhine based on national and international administrative agreements and eventual proposal for optimizing the agreements	Implemented	(1) Improve flood forecasting, flood announcement and flood warning based on the most recent knowledge **(NEW)**	x	x	x	
(2) Continuation and permanent improvement of the existing international cooperation in the field of flood forecasting and of early warning systems	Implemented (permanent task)	(2) Continue the ongoing international cooperation before and during a flood event **(NEW)**	x	x	x	
4.4 Implementation of measures aimed at lowering the water levels		**4.3. Implementation of water level reduction measures and keeping areas clear/open**				
(1) Implementation of water level reduction measures by 2030 (2027). Keeping runoff corridors free.	Partly implemented/Not yet accomplished	(1) Implementation of water level reduction measures by 2027	x	x	x	
(2) Safeguarding of the areas for the measures mentioned under (1) in spatial planning	Partly implemented/Not yet accomplished	(2) Enhance keeping floodplains free from constructions	x	x	x	
		(3) Identification and bundling of possible further water level reduction measures along the Rhine and in its catchment beyond 2027 **(NEW)**	x	x	x	
		(4) Synergies of flood protection measures, ecology and water quality **(NEW)**	x	x	x	
		(5) The points (1) to (4) also include measures in the tributaries and small affluents in the Rhine catchment. **(NEW)**	x	x	x	

* Implemented here means that the processes associated with the permanent tasks are established and the necessary instruments are provided.

** Measure is also subject to the "General objective" for 2040: "The Rhine and its Catchment: sustainably managed and climate-resilient"

Annex 9 - Coherence of measures of the 2nd IFRMP and targets and measures of "Rhine 2040"

Measures of the 2nd IFRMP of the IRBD Rhine	Objectives for the 2nd IFRMP				Specific goals of the Rhine 2040 programme for 2040 compared to 2020							Links with the measures of the Rhine 2040 programme
	1	2	3	4	1	2	3	4	5	6	7	
4.1 Improved exchange of information and access to information												Concerning the specific goal 1: • The flood information, forecast and warning systems are up to date and adequate training is undertaken. The nations support each other in the event of a flood. • Continuous improvement of flood information, forecasting and warning on the basis of current/new knowledge as a permanent task of flood risk management. Concerning the specific goal 2: • Further methodical improvement of knowledge about the risks and effectiveness of different measures of flood risk management, for example with the help of verification instruments like the FloRiAn tool (Flood Risk Analysis); regular reviews of effectiveness every 6 years (2027, 2033 and 2039); recalculation of the effectiveness of planned measures - depending on the availability of data. Concerning the specific goal 6: • The examination of property protection measures in the case of existing buildings in flood areas, in particular in the event of changes or renovations within the framework of building approval; • The flood-adapted construction of new buildings that cannot be avoided in flood areas; • The promotion of the continuous exchange of knowledge between the nations regarding these measures. Concerning the specific goal 7: • Improving flood risk communication with the aim of expediting the implementation of non-technical measures (damage prevention, building precautions, natural hazard insurance, etc.), i.e. the focus is on independent action. The ICPR supports these activities with appropriate events; • Promotion of an intensive exchange of information, and the involvement of the public in the nations of the Rhine catchment area via the provision of information, advice, training, exercises, prevention in educational, civic and youth projects, round tables and the formation of municipal flood partnerships for the correct, damage-reducing handling of flood events. The ICPR can support these activities. Note: Updating the discharge projections and updating the climate change adaptation strategy are measures under the general objective for 2040 "The Rhine and its catchment area: sustainably managed and climate-resilient"
(1) Improved knowledge on flood risk	x	x	x									
(2) Exchange on the development of models and contribution to the updating of the climate change adaptation strategy	x	x	x									
(3) Improve flood awareness	x	x	x		x	x				x	x	
(4) Exchange on national building precaution and flood adaptation measures	x	x	x									
(5) Exchange on crisis management and recovery			x	x								
4.2 Improve flood forecasting and flood warning												Concerning the specific goal 1: • The flood information, forecast and warning systems are up to date and adequate training is undertaken. The nations support each other in the event of a flood. • Continuous improvement of flood information, forecasting and warning on the basis of current/new knowledge as a permanent task of flood risk management.
(1) Improve flood forecasting, flood announcement and flood warning based on the most recent knowledge	x	x	x		x							
(2) Continue the ongoing international cooperation before and during a flood event	x	x	x									
4.4. Implementation of measures aimed at lowering the water levels												Concerning the specific goal 2: • Realisation of further water retention measures by 2030; implementation must be accelerated; • Keeping free from construction the areas on the Rhine and the tributaries, for the retention areas still to be implemented; • Further methodical improvement of knowledge about the risks and effectiveness of different measures of flood risk management, for example with the help of verification instruments like the FloRiAn tool (Flood Risk Analysis); regular reviews of effectiveness every 6 years (2027, 2033 and 2039); recalculation of the effectiveness of planned measures - depending on the availability of data. Concerning the specific goal 3: • Identification and compilation of other possible areas for further flood retention on the Rhine and Rhine tributaries and/or in the Rhine catchment area, which go beyond the measures to be implemented by 2030.
(1) Implementation of water level reduction measures by 2027	x	x	x									
(2) Enhance keeping floodplains free from constructions	x	x	x									
(3) Identification and bundling of possible further water level reduction measures along the Rhine and in its catchment beyond 2027	x	x	x			x	x	x	x			
(4) Synergies of flood protection measures, ecology and water quality	x	x	x									
(5) The points (1) to (4) also include measures in the tributaries and small affluents in the Rhine catchment. **(NEW)**	x	x	x									

Annex 10 - Assessment of the effect of flood risk measures with the help of the tool "ICPR FloRiAn" *(Summary of the results of the ICPR Expert Group HIRI, see ICPR technical report no. 283)*

In 2015, the ICPR developed an innovative quantitative method and an associated GIS tool for determining flood risks and the impact of risk reduction measures. The unique tool "ICPR FloRiAn (Flood Risk Analysis)" is used to assess the development of flood risks on the Rhine and to regularly review the effects of measures on flood risk within the framework of the International flood risk management plan for the International River Basin District "Rhine"[41] and is based on the measures of the national/regional FRMPs. It is the EU Floods Directive (FD) which is decisive for the measures and the protected assets. The flood hazard maps with low, medium and high probabilities (hereinafter referred to as $HQ_{extreme}$, HQ_{medium}, $HQ_{frequent}$), the four protected assets of the FD (human health, environment, cultural heritage, economic activities) of the flood risk maps and various types of measures are used as input data for the FloRiAn instrument.

At the end of 2015, the instrument was used to carry out calculations on the effectiveness of the measures in terms of risk reduction since 1995 (see ICPR technical reports no. 216 and 217). The recommendations for the future use of the tool also take into account experience gained from external applications.

In 2016, the ICPR Working group "Flood and Low water" (WG H) entrusted the EG HIRI with the following tasks:

- Monitoring and evaluation of the 1st IFRMP 2015 - 2021: Do the measures that have been implemented nationally by 2020 (or 2021) show a reduction of the damage potential and the risk[42]?
- Preliminary analysis of the 2nd IFRMP 2022 - 2027: How will the damage potential and the risk develop with the planned, future measures until 2030 (or 2027)?
- Studies on the effectiveness of the various flood risk management measures.

The results of the calculations on risk development up to 2030 were also compared with the new objective of the "Rhine 2040" programme (i.e. risk reduction of at least 15% by 2040 compared to 2020).

The calculations of the EG HIRI have shown the following:

- Monitoring and evaluation of the 1st IFRMP 2015 - 2021:
    - Between 2015 and 2020 the damage potential for human health (number of affected people), environment and cultural heritage were constant and increased for the protected asset economy). Reason for the general non-existent damage reduction: the water level reduction measures have no influence on the damage potential, since they only affect the probability of flooding.
    - Sharp decrease in risk between 2015 and 2020 for all protected assets. Reason: In the calculation period 2015 to 2020, numerous water level reduction measures were implemented, resulting in a reduction of the flood risk.

[41] In the report the international Plan inclusive national plans is defined as "IFRMP".

[42] Das Hochwasserrisiko ist das Produkt aus Schadenspotenzial und der Eintrittswahrscheinlichkeit eines Hochwasserereignisses. Das Schadenspotenzial beschreibt in diesem Fall die Werte, Anzahl oder Menge von vier sogenannten „Schutzgütern" (= die „nachteiligen Folgen" nach der Terminologie der HWRM-RL), die durch ein Hochwasser geschädigt oder betroffen werden können: wirtschaftliche Tätigkeiten, menschliche Gesundheit, Umwelt und Kulturerbe.).

- Preliminary analysis of the 2nd IFRMP 2022 - 2027 based on current projections on the development of damage, risks and implementation of measures:
    - For $HQ_{frequent}$ and $HQ_{extreme}$ no significant reduction in damage potential is expected between 2020 and 2030 for all protected assets. For HQ_{medium}, on the other hand, a strong decrease in the damage potential is prognosed for all protected assets. This is due to the planned dike rehabilitation measures in the Netherlands.
    - In the period 2020-2030, the calculated risk reduction is less significant. The reason for this is that along the entire Rhine, fewer water level reduction measures are planned in the period 2020 - 2030 than in the period 2015 - 2020. In this context, it has to be taken into account that in Germany the planned water level lowering measures are to be completed precisely in this period, whereas the measures in the Netherlands have already been realised by 2020.
    - The NL dike rehabilitation programme results in a strong risk reduction for HQ_{medium} between 2020 and 2030 (= best case scenario with full implementation of the planned measures on the river dikes by 2030). Therefore, the HQ_{medium} flood areas could be strongly reduced in NL. If these measures are not implemented by 2030, the risk development will be similar to that for $HQ_{frequent}$ and $HQ_{extreme}$. Note that due to the realisation of many measures on the Upper and Lower Rhine, protection against a HQ_{medium} already exists and therefore only minor changes can be observed regarding the chosen reference value due to the completion of further measures.
- Studies on the effectiveness of the various flood risk management measures used in the calculations and supplied by the states:
    - Medium to strong reduction of the risk based on the nationally delivered measures (indicators). The extent of the impact of the national measures on risk reduction varies with regard to the individual protected assets: in the case of the protected asset "human", the national measures have a major impact on risk reduction due to securing/evacuation measures. In the case of the protected assets economy, environment and cultural heritage, the national measures (indicators) still have a significant effect, but this is less than for man.
    - Strong effect of water level reduction measures and of protective measures to reduce flood prone areas when taking into account Dutch dike rehabilitation.
    - Based on the available results, it can also be concluded that all types of measures (water level reduction measures, protective measures to reduce the inundation area, national measures/indicators such as securing/evacuation) have a significant effect on the risk development. Without these measures, the damage and risks would reach a significantly higher level.

It is important to stress that the influence of a changed land use or surface is not explicitly included in these results because only a single land use dataset (namely Corine Land Cover 2018 - CLC 2018) was used for all three study years. The reason for this decision is that the CLC datasets from the different years (CLC 2006, CLC 2012, CLC 2018) were collected and processed in different ways, which strongly influences the calculated flood risk. Sensitivity calculations have nevertheless shown that an intensification of land use (e.g. increase in settlement and industrial areas) can lead to an increase in risk of up to approx. 15 % (e.g. the economy as a protected asset over a period of 12 years).

It should also be noted that the underlying data for the water level reduction measures date back to 2010. Changes that have occurred since then, e.g. from additionally implemented/planned measures or increase in retention volume with effect on water level reduction and the change in flood probability, are therefore not included in the calculations. Therefore, there is a possibility that the risk reduction in the period 2020 - 2030 may be higher than it appears on the basis of the present prognosis. In order to obtain the most up-to-date picture possible, the Expert group HIRI (EG HIRI)

recommends that, with regard to future HIRI calculations, an update of calculations by the Expert group HVAL (EG HVAL) on the effectiveness of water level reduction measures should be considered.

Note: We would like to point out that according to the states in the Rhine catchment, in accordance with the IFRMP of the IRBD Rhine, the optimal decrease of damages and risks results from the implementation of the whole spectrum of flood risk management measures, from non-technical preparedness and prevention measures to technical protection measures and crisis management. In this context, it should also be remembered that a residual risk always exists, even behind defence measures.

The countries of the Rhine basin have already achieved major successes in recent years in their efforts to reduce the risk of flooding (see the Balance on the implementation of the Action Plan Floods under the Rhine 2020 programme). However, the results of the available calculations also show that the efforts of the states should be continued in the coming years if an additional risk reduction is to be achieved in the future. They also demonstrate the solidarity between the States in the Rhine basin and the joint efforts to reduce the risk of flooding at Rhine level. Ultimately, it is clear that regular assessments of progress in this area are necessary.