Internationale Kommission zum Schutz des Rheins
Commission Internationale pour la Protection du Rhin
Internationale Commissie ter Bescherming van de Rijn

Internationally Coordinated Flood Risk Management Plan for the International River Basin District of the Rhine, Part A

December 2015

Contents

Internationally Coordinated Flood Risk Management Plan for the International River Basin District of the Rhine (Part A) (catchment areas > 2,500 km²)

December 2015

Introduction

There has been transboundary cooperation on the Rhine since the International Commission for the Protection of the Rhine (ICPR) was founded in 1950. At first, water quality was the focus of ICPR work, after the fire in a warehouse at Schweizerhalle on 1 November 1986 the "Rhine Action Programme" with its ecological aspects was added. Since 1995 and due to the great floods of the Middle Rhine and along its downstream sections in 1993 and 1995, flood protection has been an issue added to ICPR work. In the Arles declaration of 1995, the EU Ministers of Environment charged the ICPR to draft an "Action Plan on Floods", the implementation of which until 2020 was decided by the 12th Conference of Rhine Ministers in 1998 (see Annexe 1)[1]. The International Commissions for the Protection of the Moselle and the Sarre (ICPMS) and the International Meuse Commission (IMC) were then charged to draft such plans as well. Since 1998, the ICPR working group Floods regularly carries out a success control of the implementation of the four action targets of the Action Plan on Floods.

On 28 October 2013, the 15th Conference of Rhine Ministers stated that, due to the political targets of the Action Plan on Floods:

a. since the last big floods of the Rhine in 1995, the states in the Rhine catchment have invested more than 10 billion € into flood prevention, flood protection and raising awareness for floods in order to reduce flood risks and to thus improve the protection of man and goods;

b. since 2010, downstream of Basel (on the Upper and Lower Rhine) retention areas are available for up to 229 million m³ of water. Furthermore, in the Rhine delta, measures have been implemented to enlarge the river bed (Room for the River); this contributes to reduce flood peaks and flood risks;

c. in addition, renaturing measures along tributaries and smaller waters in the catchment have been carried through and, in order to improve the protection of man and goods, the security of dikes and local flood protection have been improved along certain river sections.

[1] The balance on the implementation of the Action Plan on Floods 1995-2010 - and its 4 action targets - figures in Annex 1 of the brochure "The Rhine and its Catchment - A Survey": http://www.iksr.org/en/documentsarchive/brochures/index.html

Additionally and with respect to the reduction of flood peaks strived for so far, the 15th Conference of Rhine Ministers has confirmed the usefulness of the concrete measures already planned within the Action Plan on Floods and which the states have entirely or partly integrated into the flood risk management plans according to the EU Floods Directive which entered into force on 27 November 2007 (Directive 2007/60/EC, FD).

This directive sets new standards with respect to the flood-related policy of EU Member States. The target of the directive is, to create a framework for the assessment and management of flood risks[2].

The targets of the Floods Directive concern the management of flood risk due to reducing potential adverse consequences of floods for human health, the environment, cultural heritage and economic activities and, as far as applicable, for non-constructional measures aimed at flood prevention and/or a reduction of flood probability[3]. These measures aim at the long term and include principles supported by all states.

The Directive stipulates extensive cooperation in the field of flood management on the level of international river basin districts[4].

Based on the principle of solidarity, the states should avoid taking measures which due to their extent and their effect considerably increase the flood risk in other countries upstream or downstream in the same river catchment or sub-catchment as long as these measures are not coordinated between the Member States concerned and a common solution has been found.

The EU Member States are in charge of implementing the Floods Directive and of reporting to the EU Commission.

In this connection, the 14th Conference of Rhine ministers staged on 18 October 2007 in Bonn charged the ICPR:

a) to update the Action Plan on Floods on the basis of the results of a feasibility study, the programme Rhine 2020 and the EC Floods directive;

b) to support the co-ordination required within the implementation of the EC Floods Directive between EU states and Switzerland, as far as the watershed is concerned in a comparable manner to what is done within the EC Water Framework Directive;

c) to update the Rhine Atlas 2001 according to guidance given in the EC Floods Directive and, in cooperation with river commissions and sub-basins, to extend it to the entire Rhine catchment.

The Action Plan on Floods will be further implemented as of 2016 within the implementation of the first and possibly second Flood Risk Management Plan according to the Floods Directive and within the Flood Risk Management Plans of the states/Länder/regions.

Measures implemented so far within the Action Plan on Floods concerned the Rhine catchment downstream the outlet of Lake Constance to the mouth of the branches of the Rhine into the North Sea. The coordinated implementation of the Action Plan on Floods within the ICPR since 1995 and the drafting of the corresponding balances every 5 years have proved to be successful and will be continued every 6 years within the now pending implementation of the Flood Risk Management Plan. The first Flood Risk Management Plan concerns the period 2015 to 2021 and will be assessed and eventually updated after 6 years. In future, the ICPR will be able to use a digital instrument developed in 2015 to

[2] Floods Directive, Article 1
[3] Floods Directive, Article 7, paragraph 2
[4] Floods Directive, Article 8

determine the reduction of flood risks and the effects of measures when assessing the implementation of the flood risk management plans in the IRBD Rhine (see annex 2).

1. Basis

1.1 Implementation of the Floods Directive in the IRBD Rhine (part A)

In the EU Member States, the authorities listed in Annex 3 are in charge of the implementation of the Floods Directive in the IRBD Rhine[5].

The ICPR is carrying out the coordination and exchange of information indicated in the Floods Directive for the Rhine river basin.

The international river basin district (IRBD) defined by the Floods Directive is identical with the Rhine river basin district for the implementation of the Water Framework Directive (WFD)[6] and refers to the network of water bodies at level A (catchment areas > 2,500 km²).

In order to fulfil the obligation to coordinate according to the Floods Directive,[7] the states and Länder/regions with a share in the IRBD Rhine decided to follow the principle of subsidiarity and drafted a flood risk management plan composed of:

- A 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;
- And national and/or regional management plans as well as such coordinated at the level of international sub-basins (part B). This is for example the case for the Alpine Rhine/Lake Constance, for the Upper Rhine and for the Moselle-Sarre area (ICPMS). With respect to taking into account national and regional measures please refer to the national and regional flood risk management plans (see Annex 4).

When drafting the Flood Risk Management Plan Rhine (part A) based on national and regional Flood Risk Management Plans, the objectives and measures of the national and regional flood risk management plans were analysed and checked with respect to their compatibility. The analysis showed that these are compatible (see Annex 4).

The EU Commission provides for a WISE reporting[8] using Reporting Sheets[9]. The EU-Member States are in charge of reporting to the Commission.

As a non EU member, Switzerland[10] is not obliged to implement the Floods Directive. As was the case within the implementation of the Water Framework Directive, and based on national law, Switzerland has supported the coordination of the EU Member States with respect to implementing the Floods Directive. The same is true of Liechtenstein, as long as the Floods Directive is not transposed into law in the EEA.

[5] Floods Directive, Article 2
[6] Floods Directive, Article 2
[7] Floods Directive, Article 8
[8] WISE: Water Information System for Europe: http://water.europa.eu/
[9] „Guidance for Reporting under the Floods Directive (2007/60/EC)- Guidance Document No. 29: A compilation of reporting sheets adopted by Water Directors"
(Link: http://icm.eionet.europa.eu/schemas/dir200760ec/resources)
[10] In the non EU Member State Switzerland the treatment of natural risks is determined in the national "Strategy Natural Risks Switzerland". The national targets and focal points of actions are defined in a document published in 2011, "Living with Natural Risks - Targets and Focal Points of Action of the Swiss Federal Agency for Environment" and are part of the planning for the legislation period 2012-2012 of the Swiss Federal Council.

1.2 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). The source area of the Rhine lies in the Swiss Alps. From there the Alpine Rhine flows into Lake Constance. Between Lake Constance and Basel, the High Rhine largely forms the frontier between Switzerland and Germany. North of Basel, the Franco-German Upper Rhine flows through the lowlands of the Upper Rhine. The Middle Rhine, into which the Moselle flows in Koblenz, starts at Bingen. In Bonn, the river leaves the low mountain regions and becomes the German Lower Rhine. Downstream of the German-Dutch border, the Rhine splits into several branches (Waal, Nederrijn/Lek, IJssel) and, together with the R. Meuse, it forms a wide river delta. The Wadden Sea adjacent to Lake IJssel fulfils an important function in the coastal ecosystem.

Table1: Some characteristics of the Rhine catchment area

Surface	Approx. 200 000 km²
Length main stream Rhine	1.233 km
Mean annual discharge	338 m^3/s (Konstanz), 1.253 m^3/s (Karlsruhe-Maxau), 2.290 m^3/s (Rees)
Tributaries: Catchments > 2,500 km^2	Aare, Ill (FR), Neckar, Main (Regnitz, Fränkische Saale), Nahe, Lahn, Moselle (Saar, Meurthe, Sauer), Sieg, Ruhr, Lippe, Vechte
Important lakes	Lake Constance, Lake IJssel
States	EU Member States (7): Italy, Austria, France, Germany, Luxemburg, Belgium, Netherlands, other states (2): Liechtenstein, Switzerland
Inhabitants	Approx. 60 million
Important functions	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 characterized by a "pluvial regime" with floods prevailing in winter.

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

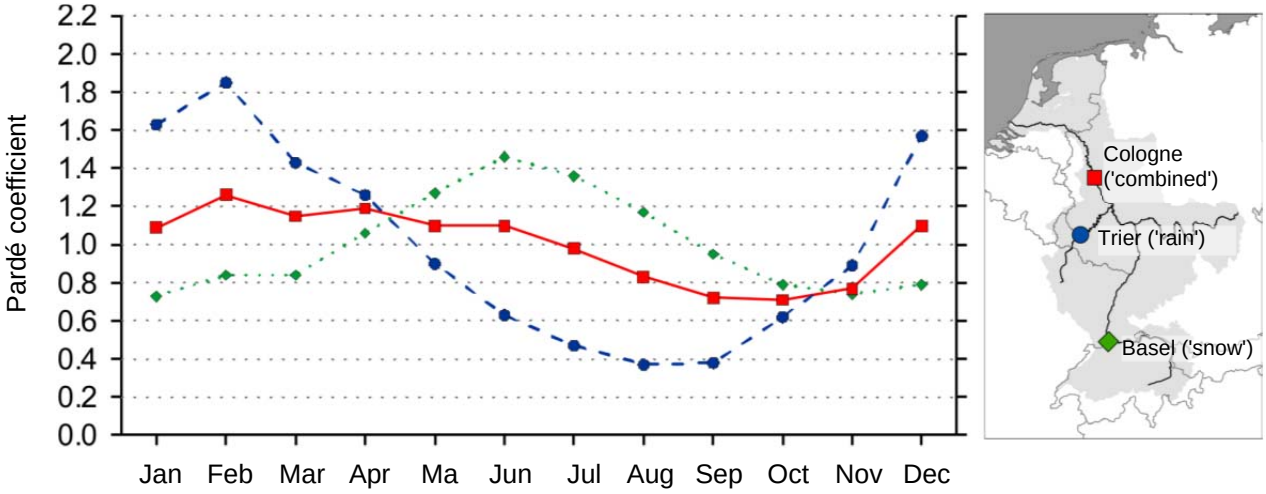


Figure 1: Typical discharge regime in the Rhine catchment according to Pardé[11]; reference period 1961-1990

The river training of the Upper Rhine which began in the 19th century was accomplished in 1977 when the Iffezheim weir 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.

The great floods in 1993 and 1995 were due to extremely high discharges in particular from the Moselle catchment and of the Rhine downstream of Koblenz and caused much damage on the Lower Rhine (1993: 1,4 billion € and 1995: 2,6 billion €).

In the beginning of February 1995, and due to the risk of dike breaches, some 250,000 people were evacuated from the Rhine delta. Another great flood was registered on the High Rhine and Upper Rhine in May 1999.

The current degree of flood protection from the Alpine Rhine to the Rhine delta is shown in Annex 5.

[11] Pardé coefficient = ratio of multi-annual monthly discharge and multi-annual annual discharge.

1.3 Aspects of climate change

Investigation results for the Rhine catchment

Considering the changing climatic frame conditions, a trend to more precipitation (pluvialisation) leading to an increase of average discharge in winter (November until April) was already perceptible during the 20th century. The seasonal distribution of discharges has become more homogenous in the south, while the differences in discharge increase in the north.

In short, the studies[12] at hand show that climate change and rising temperatures in the Rhine catchment might lead to changes of precipitation and discharge until 2050 and 2100 as listed below.

a. during the hydrologic winter:

- Increased precipitation in winter
- Increased discharge
- Early melting of snow/ice/permafrost, shift of the line of snowfall

b. during the hydrologic summer:

- Decreasing precipitation (but possibly more often heavy rainfall in summer)
- Decreasing discharges
- Increasing periods of low flow.

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

Considering the near future, some changes remain moderate, but the direction changes might take becomes clear when considering the distant future, that is, the end of this century.

The climate models presently available have to deal with numerous uncertainties. 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.

According to model calculations based on the projections at hand, the development until 2050 is characterized by a continuous rise in temperature which, in the entire Rhine catchment, and for the period 2021 to 2050 compared to the present (1961-1990) could amount to an average of + 1 °C to +2 °C and for the period 2071-2100 of +2 °C to +4 °C. In the south (Alps) it will tend to be greater than in the north.

A summary of projections for future discharges is found in Annex 6 and has been published earlier in the Annex of the ICPR Strategy to adapt to climate change[13] (Report no. 219, Annex 2).

Effects on measures of flood risk management

The Floods Directive[14] stipulates that the presumable effects of climate change on floods are to be taken into account. Increased attention must be paid to possible changes when

[12] ICPR report no. 188 (2011); here see: http://www.iksr.org/en/themen/klimaaenderung/index.html
[13] ICPR report no. 219 (2015); here see: http://www.iksr.org/en/themen/klimaaenderung/index.html

reviewing every 6 years the preliminary flood risk assessment (first review by 22 December 2018) and the Flood Risk Management Plan (first review by 22 December 2021).

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 depth/peaks, duration/load and frequency of flood discharges and the resulting change of flood risk.

The states in the Rhine catchment have already implemented several measures convened in 1998 within the Action Plan on Floods of the Rhine. Many of the measures may be considered as win-win and no-regret measures. That means that they not only have a positive effect on flood prevention, but also on water quality and ecology. Among them in particular measures such as water retention in the entire catchment, maintaining and/or extending floodplains, dike relocations, renaturing measures, extensification, creation of retention areas, etc.

Many of the measures described in chapter 4 and which are implemented in the states within the first Flood Risk Management Plan range among such no-regret and win-win measures. They also have a positive effect on changes of the water balance brought about by climate change.

Following the instructions of the 15th Conference of Rhine Ministers, the ICPR has drafted a strategy to adapt to climate change based on the above mentioned aspects[15].

[14] Floods Directive, Article 14
[15] ICPR report no. 219 (2015); here see: http://www.iksr.org/en/themen/klimaaenderung/index.html

2. Flood risk in the Rhine catchment

2.1 Preliminary assessment of flood risk and determination of flood risk areas (part A)

The map in Figure 2 shows the areas with a potential significant flood risk in the Rhine catchment (part A)[16]. The corresponding ICPR report[17] includes indications on areas at risk for which the authorities in charge in the different Member States have exchanged information and coordinated measures.

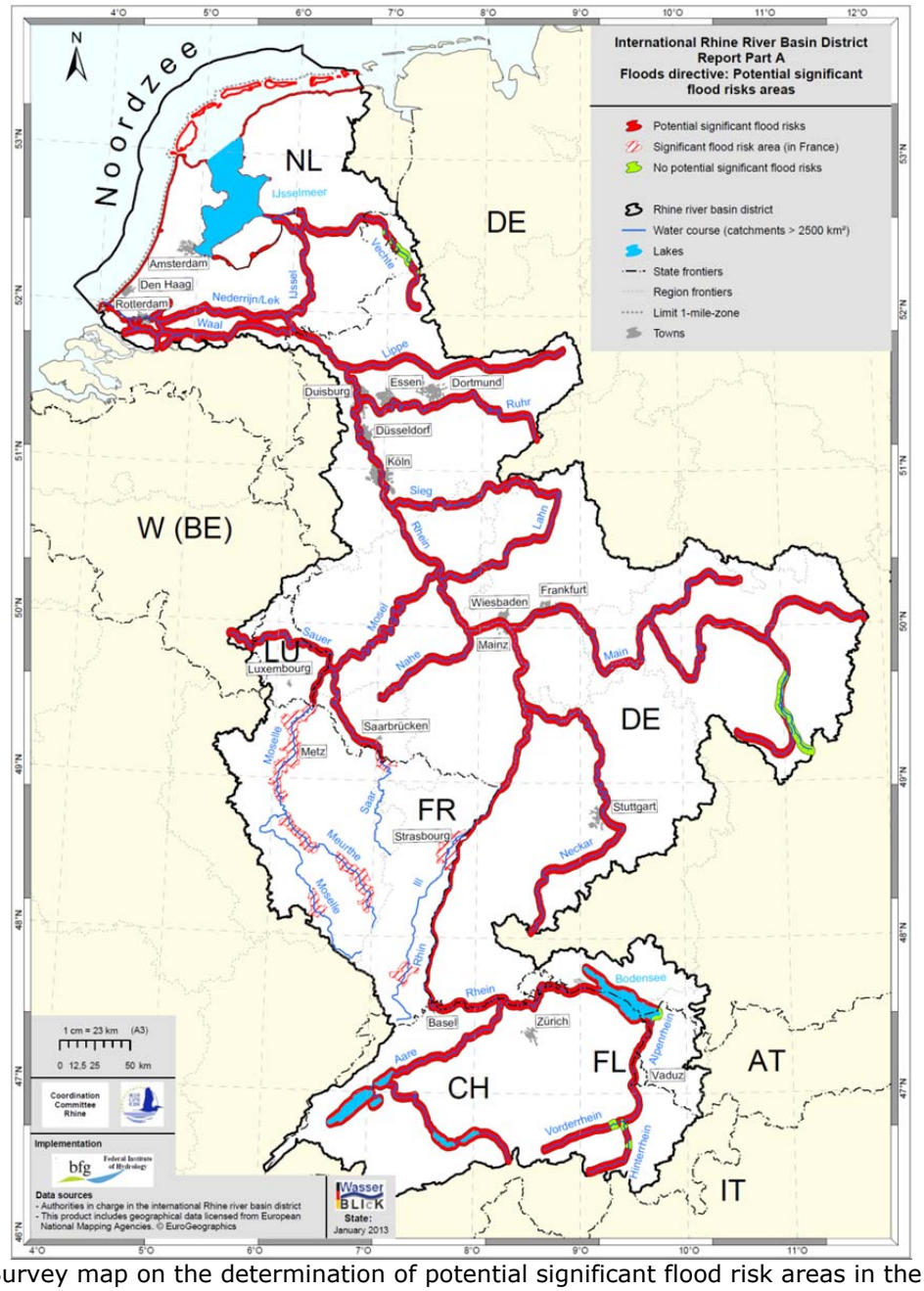


Figure 2: Survey map on the determination of potential significant flood risk areas in the IRBD Rhine (part A)

[16] Floods Directive, Articles 4, 5, and 13
[17] http://www.iksr.org/fileadmin/user_upload/Dokumente_en/Reports/FD-1st_report_01.pdf

2.2 Description of flood hazard and flood risk (part A)

The "Report on the drafting of Flood Hazard Maps and Flood Risk Maps in the International River Basin District ‚Rhine'"[18] presents the results of the exchange of information on the maps of flood risk and flood danger (part A). It also includes the internationally agreed discharge values for the three flood scenarios for the main stream of the Rhine, Lake Constance, Lake IJssel and the Dutch coast which have also been used for the national maps.
The survey map in Figure 3 presents river sections or areas for which the member states have drafted flood risk maps and flood hazard maps (part A).

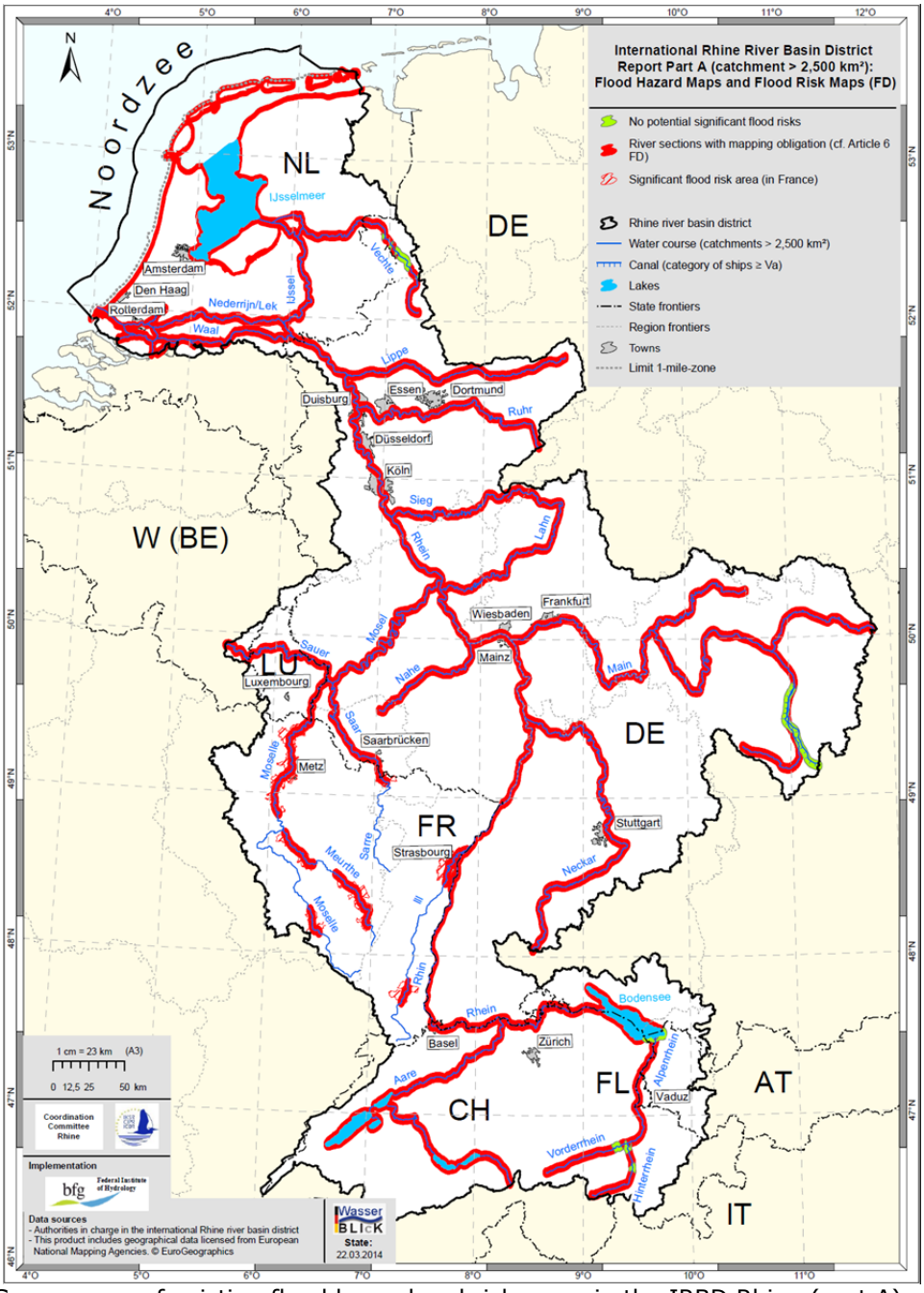


Figure 3: Survey map of existing flood hazard and risk maps in the IRBD Rhine (part A)

[18] http://www.iksr.org/fileadmin/user_upload/Dokumente_en/Communique_/FD_-_2nd_report.pdf

The ICPR Rhine Atlas of 2001[19] has been updated on the basis of the national maps of flood hazard and flood risk.

The "Interactive Rhine Atlas 2015"[20] has been drafted for the entire main stream from the Alpine Rhine to the North Sea, including Lake Constance and Lake IJssel.

The drafting of the Interactive Rhine Atlas 2015 is based on the preliminary international coordination within the ICPR.
Considering the internationally agreed discharge values for the three flood scenarios (low, medium and high probability), the Interactive Rhine Atlas 2015 presents maps of flood hazard and now also of flood risk for areas designated due to a potentially significant flood risk.

Annex 7 presents the list of internet links to national or regional map portals for flood hazard and flood risk as well as the legend to the Interactive Rhine Atlas 2015 of the ICPR.

The Interactive Rhine Atlas 2015 also includes links to all portals of member states, regions, federal states in order to be able to visualize detailed maps of the Rhine and its main tributaries.

The national reports or the reports for sub-basins (e.g. Moselle-Sarre of ICPMS) contain the details on how the maps were drafted for flood risk areas for which coordination is required in border regions.

3. Principles and targets of the overriding Flood Risk Management Plan (part A)

The Flood Risk Management Plan (part A) describes measures with transboundary effects and measures which the states concerned esteem to be relevant.
Principles and targets are described in the chapter at hand. The framework is given by the Floods Directive.

3.1 Principles

Flood risk management in the international Rhine river basin rests on the basic values of responsibility, solidarity and appropriateness as well as on synergy with other EU policies.

Flood risk management is holistic and sustainable; the level of security to be achieved must be ecologically acceptable, economically reasonable and socially acceptable.

Flood risk management is a community task. Therefore, all those implied and concerned must develop, solidify and maintain risk awareness.

Such tasks can only be carried out jointly with a distinct distribution of tasks. Decision makers, technical institutes and authorities must cooperate at all levels (local, regional, national, international) with one another and with the user groups/actors concerned. Cooperation with the population is particularly important at a local level.

[19] http://www.iksr.org/de/dokumentearchiv/rheinatlas/index.html
[20] The Interactive Rhine Atlas 2015 is available at http://www.iksr.org/de/dokumentearchiv/rheinatlas/index.html.

Even an optimal combination of measures within flood risk management does not grant absolute security when handling nature events (such as extreme floods): The remaining risks require an approach beyond mere protection. That means that the residual risks must be acceptable to risk bearers. If the residual risk should be too high, an adaptation or relocation of uses may be attempted.

3.2 Targets of the overriding plan: From the Action Plan on Floods towards the Flood Risk Management Plan

The target of flood risk management is to reduce flood risks to a socially acceptable level and to prevent unacceptable risks so as to secure living areas and economic areas for the future. Regarding a more long term future (about 20-30 years), reasonable security is to be created for man, buildings, infrastructures and immobile goods and to be maintained for the long term.

The targets of the Flood Risk Management Plan (part A) have been defined with respect to the targets of the Floods Directive and take into account regional management processes in the member states/Länder and regions.

The Floods Directive has created a new situation requiring an integral approach to flood risk. The overriding targets now also include crisis management and recovery.

The targets of the overriding Flood Risk Management Plan replace the four action targets of the Action Plan on Floods.

Considering the provisions of the Floods Directive[21] stipulating that the flood risk management plans comprise all aspects of flood risk management but focussing on prevention, protection and preparedness, the states in the Rhine catchment have agreed upon the following overriding, general targets:

(1) Avoid new, unacceptable risks

This target replaces the action target no. 1 of the Action Plan on Floods concerning the reduction of flood risks and the action target no. 3, the sensitization of all actors and persons concerned with flood risk maps. This target also corresponds to the principle that considering aspects of solidarity, national flood risk management plans may not include any measures which due to their extent and effect may considerably increase the flood risk in other upstream or downstream countries in the same catchment or sub-catchment unless these measures are coordinated and a joint solution has been found by the Member States concerned and within Article 8 of the Floods Directive.

[21] Floods Directive, Article 7, paragraph 3

(2) Reduction of existing risks to an acceptable level

This target corresponds to the action targets no. 1, 2 and 3 of the Action Plan on Floods: reduction of flood risk and flood levels on the one hand, sensitization of all actors and persons concerned on the other.

(3) Reduction of adverse consequences during a flood event

This target corresponds in particular to the action targets no. 3 and 4 of the Action Plan on Floods, awareness of the riverine population for flood-related issues and improvement of the flood warning system and the flood forecasting system.

(4) Reduction of adverse consequences after a flood event

No action target of the Action Plan on Floods corresponds to this new target which mainly concerns national crisis management and eventual compensation for those concerned.

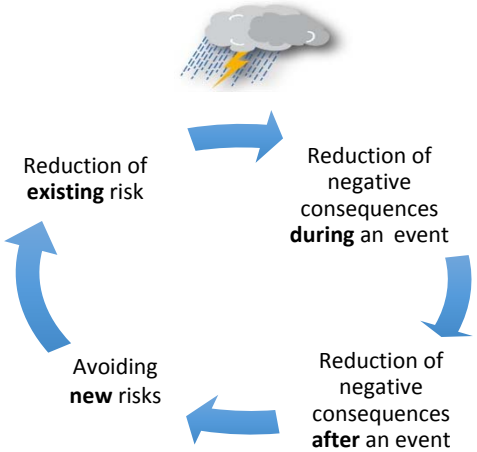


Figure 4: Overriding targets and simplified risk management cycle

These overriding general targets are part of a risk management cycle (see Figure 4). All these targets require a solid technical basis, such as shown in the maps on flood danger and flood risk.

Relying on these targets, the measures listed in chapter 4 have been agreed upon. The major results of the implementation of the Action Plan on Floods which are also part of the Balance 1995 - 2010[22] are a solid basis for measures of the flood risk management - also those at a national level.
Annex 1 presents a short survey of results achieved so far.

22 http://www.iksr.org/fileadmin/user_upload/Dokumente_en/Brochures/IKSR_BRO_210x297_ENG_26.09.13.pdf

4. Flood risk management
Summary of joint measures for the international river basin district Rhine (part A)

The Flood Risk Management Plan for the international river basin district (IRBD) Rhine describes measures with transboundary effects and measures, for which an international coordination and - in any case - an exchange of information between the states in the Rhine catchment are important.

The national, regional or local reports on the Flood Risk Management Plans include surveys of all national measures and all details on national flood risk management (see links to national plans and international sub-basins in Annex 4).

4.1 International coordination of measures

The EU Member States in the Rhine catchment are in charge of implementing the Floods Directive and apply the principles of subsidiarity and solidarity. In order to respect these provisions, the states, Länder and regions within the IRBD Rhine (part A) have agreed not to increase flood risks outside their respective territories. To this end, they will effectively coordinate measures with transboundary effects.

The have agreed upon the following approach:

(1) **Regional or local** measures which are known **not to have any transboundary effects** will be planned and implemented regionally/locally.
(2) For **regional** measures with **transboundary effects** there will at first be an exchange of information at a bilateral level or within river basin commissions for sub-basins, as for example the Moselle (Sarre). Eventually, these measures must be coordinated on a bilateral or trilateral level in order to find joint solutions. As an example, Annex 8 presents the catalogue of measures for the Moselle-Sarre catchment of the ICPMS;
(3) The measures with regional effects 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 (see chapter 4.4). 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;
(4) Enhancement of national or regional agreements targeted at keeping floodplains free of all uses; exchange on these activities within the ICPR.

The afore described approach is applicable to measures such as creating retention areas, dike relocation, room for the river and measures regulating discharges, the construction or strengthening of dikes, etc.

Measures aimed at coordinating the Floods Directive with the Water Framework Directive

According to the Floods Directive, Article 9, the states, Länder and regions in the IRBD Rhine are obliged to take appropriate measures in order to coordinate the implementation of this Directive and that of the Directive 2000/60/EC establishing a framework for Community action in the field of water policy (WFD), focussing on the possibilities to improve the efficiency and the exchange of information and to achieve synergies and joint advantages with respect to the environment targets of Article 4 WFD (see Annex 9).

The Floods Directive provides for a coordination of the drafting of the first Flood Risk Management Plans with the assessments of the Management Plans for the catchment areas according to Article 13, Paragraph 7 WFD.

In order to create synergies between measures under the Floods Directive and those under the WFD, the EU Resource Document "Links between the Floods Directive (FD 2007/60/EC) and Water Framework Directive (WFD 2000/60/EC)" are taken into account.

Further possibilities for synergies might arise, when the measures aimed at creating retention areas, dike relocation, at creating backwaters or deepening the river forelands are carried out in parallel with the extension or restoration of habitats or ecological connections aimed at improving the ecological water quality. The synergy of measures aimed at improving flood prevention such as extending floodplains by relocating dikes and measures aimed at ecological improvement, such as renaturing measures carried out within the implementation of the WFD and which contribute to retain water on surfaces must be used to a largest possible extent (see Figure 5, Annex 9, 11-1 and 11-2).

Figure 5a: Example of extension on the Alpine Rhine at the mouth of R. Frutz in Au, Vorarlberg, Austria (*Source: Renaturierung Alpenrhein /©: Internationale Rheinregulierung IRR/Hydra-Institute, Peter Rey)*

Figure 5b: Example of a river extension measure at Lent/Nijmegen, Netherlands. Dike relocation Lent, left: present situation, right: future situation (Programme "*Room for the River*", project "*Room for the R. Waal*" http://www.ruimtevoordewaal.nl /©: *Ruimte voor de Waal.)*

Not only ecological synergy effects are being looked at, but an improvement of the quality of life, living, work, in short, an improvement of the living space on the whole is strived for (see Figure 5b).

With respect to climate change and enhanced resilience of nature-near water ecosystems, a holistic survey of further measures aimed at reducing the water level along the Rhine will be established based on existing investigations in the states or Länder.

As an example, the catalogue of measures for the Moselle-Sarre area in Annex 8 also includes information on possible synergies between the Floods Directive and the Water Framework Directive.

As far as measures in the IRBD Rhine (part A) are concerned, possible synergies with the environmental targets of the WFD will be enhanced and the environmental effects of measures liable to cause a deterioration of the ecological state of water bodies will be reduced to a minimum.

4.2 Improved exchange of information and access to information

With respect to floods, the states, Länder and regions in the IRBD Rhine require reliable tools of information and a reliable technical basis on which to determine priorities and for later technical, financial and political decisions in the field of flood risk management (flood hazard and risk maps, estimation of eventual adverse consequences of different flood scenarios, etc.).

The states, Länder and regions in the IRBD Rhine will enhance the international cooperation and the exchange of information required by the Floods Directive, in order to profit from synergy effects and mutual advantages resulting from the exchange of required data and experience concerning flood events, in particular in water bodies on the frontiers and transboundary waters. An example of such a bilateral cooperation is the German-Dutch Working Group "Floods" looking into the long term flood risk along the dike rings on the Lower Rhine. 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.

At a regional, national and international scale, the public has been informed and involved in discussions on the plans at an early stage. In this connection, the observers (NGOs) served as intermediates between the public and the ICPR. This information and involvement into activities will be continued in the future.

Concrete joint measures

(1) Improvement of knowledge on the flood risk through exchange of information (in particular concerning transboundary waters)

As a part of knowledge management, there is an exchange of information on new political approaches in flood risk management (prevention, protection, preparedness and recovery), on important measures implemented and on national findings as well as on the results of the updating of flood hazard and risk maps comparable with the procedure concerning the Rhine Atlas 2015.

As of 2016, the ICPR will be able to comprehensively analyse flood risks along the Rhine with the help of a new instrument (geographic information system GIS) which is also capable of identifying the effects of individual flood risk management measures (see Annex 2).

(2) Exchange of information on the development of hydraulic and hydrological as well as climate-related models in the Rhine basin

Since the project "Rheinblick 2050" concerning the effects of climate change on discharges of transboundary water bodies, the states, Länder and regions in the IRBD Rhine reinforce their exchange of information on the results of studies in order to better take into account presumable effects of climate change on the occurrence of floods[23]. This is in particular done in connection with the revision of the ICPR report on the preliminary flood risk assessment in 2018 and the overriding Flood Risk Management Plan of the IRBD Rhine in 2021.

(3) Sensitize the population

The mutual exchange of information on flood risk management is done at ICPR level. The population is also being well informed on a national, regional or local scale, so that regional specifics may be taken into account. Thus, sensitization is particularly a regional and local issue. Furthermore, reference is made to intercommunal cooperation, e.g. in flood partnerships which may play an important part in flood prevention and information. Sensitization can be supported by supra-regional measures at ICPR level, such as with links on the floods issue on the ICPR website, the ICPR website for children[24], different public relation activities, brochures and drafting and, if required, the further development of the new digital Interactive Rhine Atlas 2015[25].

[23] Information: In 2015, the ICPR published the first strategy for adapting to climate change for the IRBD Rhine; see: http://www.iksr.org/en/themen/klimaaenderung/index.html
[24] The ICPR website for children is found under http://kids.iksr.org/index.php?id=18. It gives information on floods for the younger public.
[25] The Interactive Rhine Atlas 2015 is available at http://www.iksr.org/en/dokumentearchiv/rheinatlas/index.html.

(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 recovery measures national disaster protection organisations and national recovery measures

Good crisis management planning for flood events is important in order to be able to reduce risks during the event. This is a task for disaster protection or civil protection in the different states. At EU level there was a mechanism states could use to ask other EU Member States for help in the event of nature disasters. Since 2014, this is a task for the Emergency Response Coordination Centre (ERCC)[26]. Compiling a survey of existing multilateral, bilateral and national crisis management systems may improve knowledge on such systems in the Rhine catchment. If necessary, this exchange of information will enable improvements in this domain. This also applies to recovery measures.

4.3 Improve flood forecasting and warning systems

Flood forecasting and flood announcement contribute to reducing damage in case of a flood event. They present a decisive prerequisite for measures aimed at securing potentially concerned goods and persons against waters overtopping their banks. Therefore, the states, Länder and regions in the IRBD Rhine cooperate at an international level when exchanging data on discharge and precipitation and using them for flood forecasting.

Flood forecasting requires continuous hydro-meteorological measurements (among others realtime measurements of water gauges and/or discharge, precipitation, etc.) and model calculations representing a costly permanent task requiring much personnel for the states/regions/Länder concerned. Along the main stream of the Rhine, the flood centres in Switzerland and in the German Länder Baden-Württemberg, Rhineland-Palatinate (together with the federal Water and Navigation Administration) and the Netherlands are in charge of this task (see Figure 6 and Annex 10 with links to the flood forecasting centres in the IRBD Rhine).

[26] Resolution /1313/2013/EU: http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32013D1313&from=EN

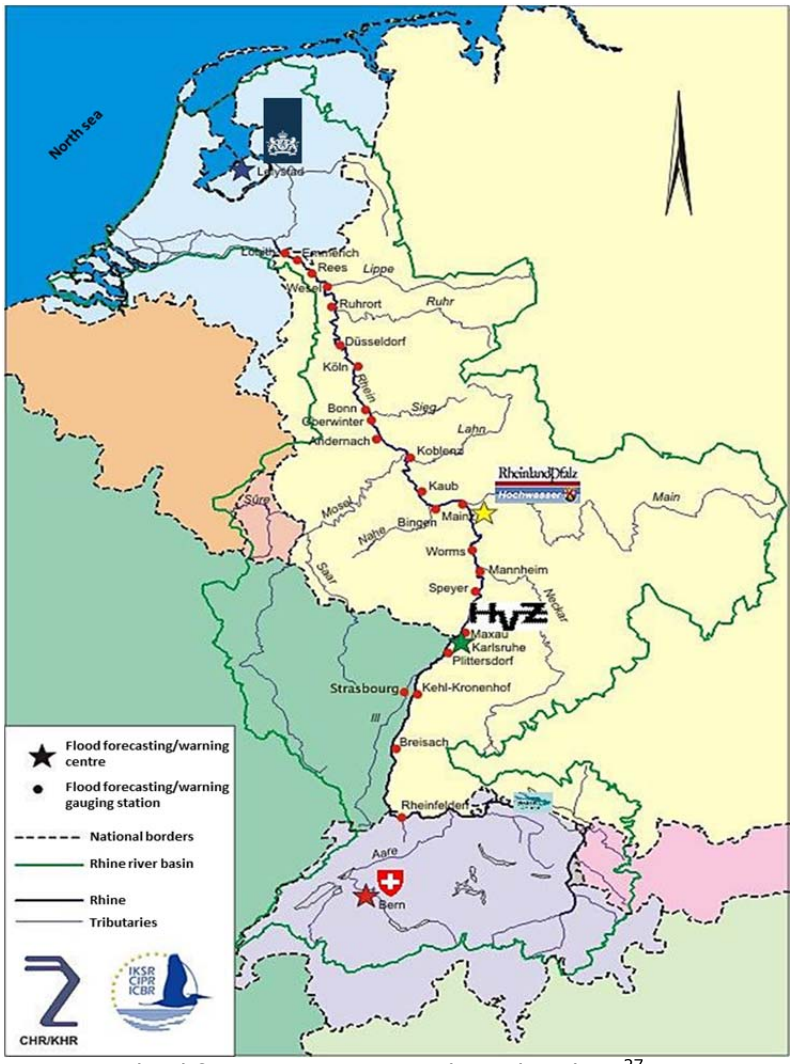


Figure 6: Flood forecasting centres along the Rhine[27]

The forecasting system for the biggest Rhine tributary, the Moselle and its catchment is taken into account in the Flood Risk Management Plan of the ICPMS (part B).

Concrete joint measures

(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

The cooperation will be further developed with new international agreements e.g. on flood forecasting, regulating the principles of mutual data exchange (e.g. passing on of data to third parties, delivering raw data and results of discharge forecasting) and jointly developed or used models or flood exercises.

[27]Interactive map available at: http://www.iksr.org/en/themen/hochwasser/melde-und-vorhersagezentralen/interaktive-karte/index.html

(2) Continuation and permanent improvement of the existing international cooperation in the field of flood forecasting and of early warning systems

In future, the annual meeting of flood forecasting centres will be staged by the ICPR and be part of the activities of the Working Group Floods.

An exchange of information and experience concerning early warning systems informing the population about floods in minor catchment areas will be staged within the ICPR - in so far as of interest at level A - in order to learn from one another.

4.4 Implementation of measures aimed at lowering the water levels

The 15th Conference of Rhine Ministers in 2013 stated that, due to the effects of climate change and the expected increase of the number of flood events and also considering the possibility of a greater probability of extreme events, in particular supra-regional flood risk management measures, such as keeping flood-prone areas free from further uses or creating more flood retention areas/more room for the river will become increasingly important.

In this connection, the further and consequent implementation of all measures aimed at lowering water levels or of retention measures in the states of the Rhine catchment planned until 2020 within the frame of the Action Plan on Floods must be underlined.

Concrete joint measures

1. Measures from the Action Plan on Floods aimed at lowering the water level and indicated in the Annexes 11-1 and 11-2, the implementation of which is planned until 2020, e.g. future retention areas, dike relocation, room for the river, renaturing (see Chapter 4.1). Also, it is important to keep discharge corridors free. Annex 11-1 and the "Retention measures between Basel and Lobith" list a number of flood retention areas planned until 2020. Annex 11-2 lists the most important measures aimed at lowering the water level of the Delta Rhine as of Lobith until 2020 indicating the expected minimum reduction of the water level (in cm). Both tables only list measures the supra-regional effect of which is known from comprehensive studies[28] carried out within the ICPR. Thus, there is evidence for their importance for the entire Rhine river basin district and the measures have already been coordinated.
2. Securing the surfaces of the further measures listed in Annex 11-1 and Annex 11-2 to be implemented by the states after 2020 under aspects of spatial planning so that these measures can be carried through as described in the communiqué of the 15th Conference of Rhine Ministers[29].

According to an ICPR study[30], a reduction of flood peaks as indicated in Figure 7 will be achieved once the measures listed in Annex 11-1 and Annex 11-2 will have been implemented. The results permit a substantiated evaluation of the effectiveness of

[28] ICPR report no. 199 (2012; no English version available): http://www.iksr.org/uploads/media/199_d.pdf
ICPR report no. 200 (2012; no English version available): http://www.iksr.org/uploads/media/200_d.pdf
[29] http://www.iksr.org/fileadmin/user_upload/Dokumente_en/Communique_/2013_EN_Ministerial_Declaration.pdf
[30] Balance of the implementation of the Action Plan on Floods 1995-2010 in the brochure "The Rhine and its Catchment - a Survey": http://www.iksr.org/en/documentsarchive/brochures/index.html

measures implemented and of their contribution to achieving the objectives of the Flood Risk Management Plan.

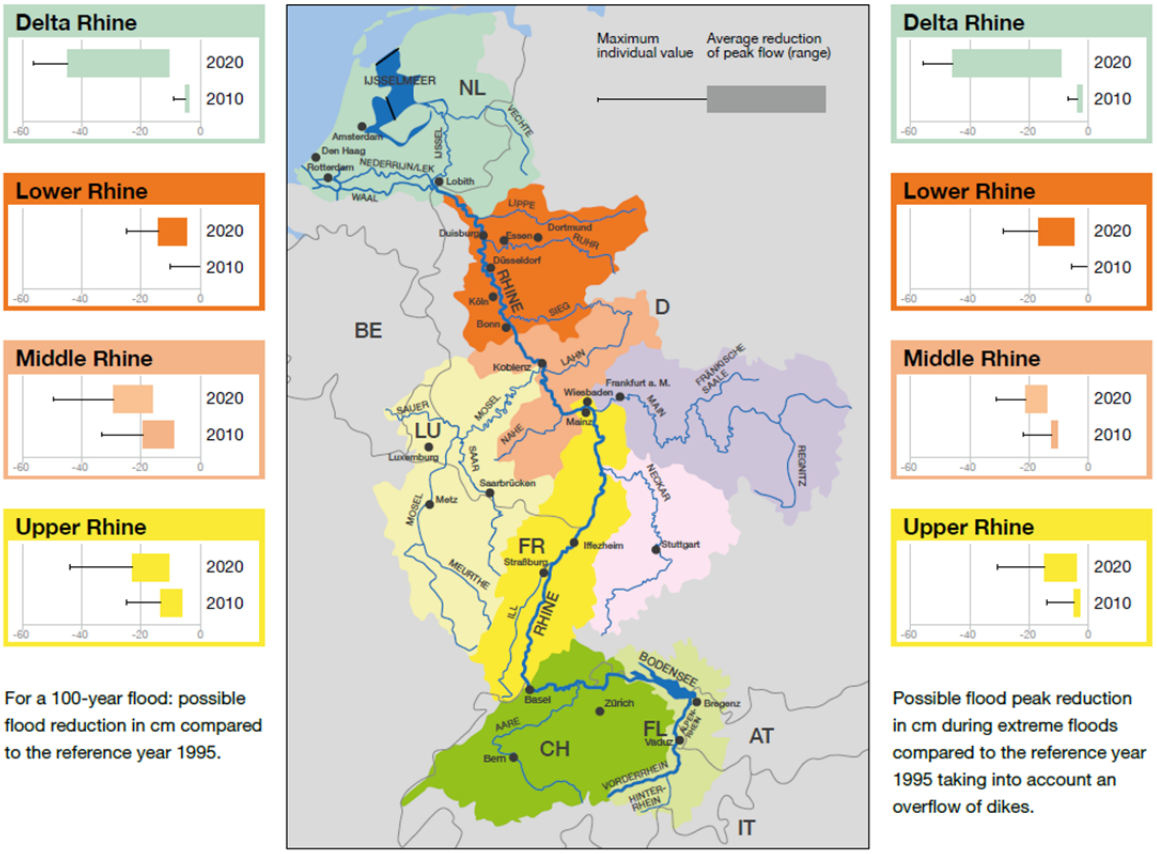


Figure 7: Possible reduction of flood peaks due to measures lowering the water level. State 2010 and 2020

The results show average changes of water stages for the different development conditions/stages of the Rhine in 2010 and 2020 along the different sections of the Rhine for a 100-year flood and an extreme flood.[31]

As shown in Annex 12, the reduction of water levels by different corresponding measures along the Rhine may equally lead to reduced flood probability. This equally results in a reduction of flood risks. The results of this study[32] were used for calculating the modification of flood risk with the GIS instrument (see Annex 2).

[31] Measures aimed at lowering water levels in the Netherlands have different effects on these three branches of the Rhine. The greatest lowering of water levels concerns the IJssel; in the rivers Waal and Lek results are less tangible. The diagram illustrates the range of average reductions across all three branches (Delta Rhine).
[32] See ICPR report no. 229 (2015) and summary lecture (no English version available): http://www.iksr.org/en/documentsarchive/technical-reports/reports-and-brochures-individual-presentation/artikel/939/index.html

5. Implementation of the Plan and review

The first Flood Risk Management Plan for the IRBD Rhine (part A) concerns the period 2015 to 2021.

It will be reviewed by 22 December 2021 and subsequently every 6 years and will eventually be updated. This also applies to the preliminary flood risk assessment until end 2018 and the maps on flood danger and flood risk until end 2019.

According to the requirements of the Floods Directive, the success of the measures implemented within the 1st Flood Risk Management Plan will be reviewed every 6 years. This is a task of the Working Group Floods and its Expert Groups beginning in 2015.

The effect of all measures implemented at a national level within the first cycle of the Flood Risk Management will have to be identified on a national as well as on an international level for the river basin district Rhine.

It is possible to calculate the effect of all measures on the flood risk, including those reducing the water level with the help of existing methods and a GIS instrument achieved in 2015 (see Annex 2). For existing measures, this calculation has now been made within the ICPR Action Plan on Floods. At the same time, calculations were made with the planned measures of flood risk management. In future, these calculations will be carried through regularly and also taking into account the measures implemented.

6. Public information and consultation

Within the implementation of the Floods Directive, the information and consultation of the public in the IRBD Rhine (part A) is following the same course as during the drafting of the management plan according to the WFD.

In most states of the Rhine catchment the public involvement concerning the draft of the first Flood Risk Management Plan is going on parallel to that of the draft of the second management plan according to WFD.

The draft of the first Flood Risk Management Plan for the IRBD Rhine (part A) was published on the public ICPR website www.iksr.org on 22 December 2014 and is thus available for public participation.

At an international level, it is above all the website of the ICPR which is used for public information. This website informs the public about the Rhine river basin district and the Floods Directive. Also, the international joint reports and publications on the balance of the Action Plan on Floods can be downloaded from this website.

In the ICPR, the acknowledged observers are represented in the working groups and the plenary assembly/coordination committee and can, therefore, participate in the discussions and present their issues. The Floods Directive provides for public involvement by means of public participation at all levels of action, which is on a local, regional, national and international scale.

ANNEXES

Annex 1 - State of flood risk management in the IRBD Rhine (part A) / Balance of the Action Plan on Floods (source: Balance of the Action Plan on Floods 1995-2010[33])

Outline of the four action targets of the Action Plan on Floods and state of achievement by 2010

Action targets of the Action Plan on Floods for the target year 2020 compared to the reference year 1995	Results of the implementation of the Action Plan on Floods by 2010 compared to the reference year 1995
1 Reduce flood damage risks by 25 % by 2020	In 2005 and based on rough estimates a reduction of damage risks was stated as compared to the state in 1995. Along the non diked sections of the Rhine, the reduction lies within the target set, however, in the diked sections, it is considerably lower. New and more detailed results are expected for 2014.
2 Reduction of flood levels - Reduction of 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)	Retention measures implemented along the Rhine itself prove to have the greatest effect on the reduction of flood levels of the Rhine. In 2010, approximately 230 million m³ of retention volume were available along the Rhine. This volume and the measures currently planned will however only achieve the maximum target set, i.e. 60 cm, in individual cases and for few floods. The target set would only be permanently achievable, if more retention areas were created and combined with measures improving runoff.
3 Increasing flood awareness by drafting and spreading flood risk maps for 100 % of flood hazard areas	This target has been achieved for the main stream of the Rhine. The maps on flood hazard and flood risk available since 2001 (see ICPR Rhine Atlas 2001) have contributed to increasing the risk awareness of the population and present a valuable means of raising awareness. Additionally, many further awareness raising measures have been implemented. Based on new data the atlas will be updated by 2014.
4 Improve the flood forecasting system - short term improvement of flood forecasting systems due to international cooperation. Prolong forecasting periods by 100 % by 2005	Until 2005, the forecasting periods along the Upper and Middle Rhine were already extended from 24 to 48 hours, along the Lower Rhine from 48 to 96 hours. In spite of many new developments in the past years, prolonged forecasting periods cannot be assumed to be as reliable as more short-term forecasting.

[33] http://www.iksr.org/fileadmin/user_upload/Dokumente_en/Brochures/IKSR_BRO_210x297_ENG_26.09.13.pdf

Summary of measures carried out between 1995 and 2010 and description of the effects of measures

Legend: (+ little effect, ++average effect, +++ strong effect, - no effect)
Action target 1 → Reduction of damage risks
Action target 2 → Reduction of flood levels
Action target 3 → Increase flood awareness
Action target 4 → Improve the flood warning system

Categories of measures	Contribution to Hz1 Hz2 Hz3 Hz4	Measures 1995-2005	Measures 1995-2010
(1) Water retention in the Rhine catchment			
Renaturing (km)	+ + + -	>2,400	>4,000
Reactivation of floodplains (km²)	+ + + -	>200	>300
Agricultural extensification (km²)	+ + + -	>4,600	>14,000
Nature development, afforestation (km²)	+ + + -	>900	>1,000
Enhance seepage of precipitation (km²)	+ + + -	60	>60
Technical water retention (million m³)	++ + + -	40	>60
(2) Water retention along the Rhine			
Reactivation of floodplains (km²)	++ +++ ++ -	30	60
Technical water retention (million m³)	++ +++ ++ -	50	70
(3) Technical flood protection			
Maintenance and strengthening of dikes, adaptation to general and local levels of protection, including local protection along the Rhine and in its catchment (km)	++ - + -	1,160	>1,400
(4) Preventive planning measures			
Raise awareness	++ + +++ -	Using websites, brochures, events and flood exercises.	
Draft hazard and risk maps	+++ + +++ -	100 %	100 %
(5) Flood forecasting			
Prolong forecasting periods	+++ - - +++	100 %	100 %
Improve flood warning and announcement systems	+++ - - +++	Improve systems and data basis, draft websites, etc.	

Annex 2 - Instrument for giving evidence of the effects of flood risk measures (Summary)

Apart from the protection of people, another of the main targets of the Action Plan on Floods of the International Commission for the Protection of the Rhine (ICPR) adopted in 1998 is to avoid damage to goods. The first action target of the Action Plan on Floods is to reduce damage risks from 10 % in 2005 to 25 % in 2020 compared to the reference year 1995. The focus of action is placed on situations of extreme floods.

In 2015, the ICPR developed a quantitative **instrument aimed at a traceable and transparent determination of flood risks and the effects of risk reducing measures.** It will be used to assess the development of flood risks along the Rhine for the period 1995 - 2020+ and for regularly determining the effects of measures on the flood risk within the Flood Risk Management Plan Rhine. If the data required are available, this instrument can also be applied to other river basins.

It is the Floods Directive which is decisive for the measures and the assets of protection. The GIS instrument uses flood hazard maps with low, medium and high probabilities, different types of measures and the 4 assets of protection of the Floods Directive (human health, environment, cultural heritage and economic activities). Indicators have been determined in order to quantify the effects of measures on the evolution of the flood risk for different assets of protection. These indicators were based on the maximum effect to be expected of the measures and their degree of implementation.

The instrument and the indicators defined will on the one hand be used to evaluate the implementation of the Action Plan on Floods during 1995-2015. On the other hand and within the implementation of the Floods Directive, the evolution of flood risk will be tracked. End 2015/beginning 2016 the instrument will be used to calculate the effectiveness of measures; the corresponding report will be published in 2016.

Based on these results the ICPR will draft recommendations for the future use of the instrument together with implementing the flood risk management plan. These recommendations may be used for evaluating the first flood risk management plan.

Annex 3 - List of the authorities in charge of the Floods Directive

State	Switzerland	Italy	Liechtenstein	Austria	Germany	Germany	Germany	Germany	Germany	Germany	Germany	Germany	France	Luxemburg	Belgium	Netherlands
Country		Lombardy region		Vorarlberg	Baden-Württemberg	Bavaria	Hesse	Rhineland-Palatinate	Saarland	North Rhine-Westphalia	Lower Saxony	Thuringia		Luxemburg	Wallonia	
Name of the authority in charge	Switzerland is not obliged to implement the EU Floods Directive (CH) Authority in charge of information / coordination: Federal Office for the Environment FOEN	Lombardy region, for great constructions such as dams, the state Ministry of Environment (IT)	Government of the principality of Liechtenstein	Federal Ministry for Agriculture, Forestry, Environment and Water Management (AT)	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, Agriculture, Nutrition, Viticulture and Forestry of the Land Rhineland-Palatinate (MULEWF)	Ministry for Environment and Consumer Protection of the Saarland (MUV)	Ministry for Climate Protection, Environment, Agriculture, Nature Protection and Consumer Protection of the Land Northrhine-Westphalia (MKULNV)	Ministry of Environment, Energy 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 for Sustainable Development and Infrastructures	Wallonian Government	Ministry for Infrastructure and Environment, if necessary together with the Ministry of Interior / Royal Affairs and the Ministry of Economy[2] (NL)
Address of the authority in charge	FOEN CH-3003 Bern	Regione Lombardia Via Pola, 14 I - 20125 Milano	Regierungsgebäude Peter-Kaiser-Platz 1 9490 Vaduz	Stubenring 1 A - 1012 Wien	Kernerplatz 9 D-70182 Stuttgart	Rosen-kavalierplatz 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	Beethoven-straße 3, D-99096 Erfurt	9, Place de la Préfecture, F – 57000 Metz	4, Place de l'Europe L-1499 Luxemburg	Rue Mazy, 25*27 B -5100 Namur (Jambes)	Postbus 20901 2.500 EX Den Haag Niederlande
Legal status of the authority in charge	National regulatory authority	Supreme water authority of the region		Supreme water authority of the Republic of Austria	Supreme water authority	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 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
Competence	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 planning, execution, control and coordination
Number of lower-level administrations	26 cantons	11 provinces and 1546 towns	1; Environmental Protection Agency	1 Land minister-president 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 governments, 26 subordinate water agencies, 1 Federal Authority for Environment and Geology)	39 (2 Direction for Structure and Authorizations, 36 Lower Water Authorities, State Authority for Environment, Water Management and Trade Control)	9 (8 Lower Water Authorities, 1 State Authority for Environment)	59 (5 district governments, 53 subordinate water agencies, 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 Federal Authority, 1 Federal Authority for Environment and Geology Thuringia, 23 Lower Water Authorities)		1 Water management authority	1 Service public de Wallonie-Direction générale des ressources naturelles et de l'environnement[1] (W-BE) Avenue Prince de Liège 15 B - 5100 Namur (Jambes) Authority in charge of the Floods Directive	10 provinces and 16 water boards and 19 regions and municipalities

1) In the future Wallonian law on transposing the WFD, the Government of Wallonia will generally be the authority officially in charge; in a second step, the government will delegate its competencies (by means of a decree of the Wallonian government) to a number of authorities and public administrations, among others the authority mentioned (DGRNE)
2) In the Netherlands, the competencies for the regional waters have been delegated to the Provinces and Water Boards.

Annex 4 - Issue of coordination, national and regional objectives and links to national or regional Flood Risk Management Plans

Based on the general strategic target set in Article 7, Paragraph 2 of the Floods Directive the Member States in the IRBD Rhine have set out the following national or regional targets.

The targets set out by Austria, Germany and the German federal states in the Rhine catchment, Luxembourg and the Netherlands with respect to flood risk management are to avoid new risks and to reduce the adverse consequences during and after a flood event.

In France, the three priority objectives of the national strategy concerning flood risks (Stratégie nationale de gestion des risques d'inondation, SNGRI)[34] are:
1. "*Increase the security of the population at risk*" (= avoid the loss of human lives as much as possible by developing forecasting, alerting, securing people and goods, training of relief workers)

2. "*Short term stabilisation and medium term reduction of expenses due to destruction brought about by floods*" (= reduce expenses for highly probable events, stabilise expenses for events of medium probability)

3. "*Considerable shortening of the lapse of time required until areas concerned return to normality*" (= create the organisational prerequisites for crisis management and return to normality after a flood event in areas concerned).

With respect to the target of flood risk management, the Dutch law on water stipulates: "...Prevent and, where necessary restrict floods ... In connection with protection and improvement of the chemical and ecological quality of water systems and their corresponding to social functions". The National Water Plan focuses on: '... The Netherlands, a secure and habitable Delta, today and in future'. On this basis, the Netherlands have formulated national targets for the categories prevention, protection and preparedness/crisis management for the first Flood Risk Management Plan."

Wallonia (Belgium) has set out 5 overriding targets continuing the PLUIES plan of 2003. They concern:

(1) the improvement of knowledge on the risks of flood and inundation;
(2) the reduction and retarding of surface runoff in the catchment;
(3) the development of river beds and floodplains considering meteorological and hydrological risks and the preservation and enhancement of natural habitats granting stability at the same time;
(4) the reduction of the vulnerability in flood risk areas;
(5) the improvement of crisis management (during a catastrophe).

In the non EU Member State Switzerland the treatment of natural risks is determined in the national "Strategy «Protection against Natural Hazards»". The national objectives and priorities for action are defined in a document published in 2011, "Living with Natural Hazards - Objectives and priorities for action of the Federal Office for the Environment (FOEN)" and are part of the planning for the legislation period 2011-2015 of the Swiss Federal Council.

When conceiving the management of natural risks, Liechtenstein has always taken the relevant Swiss considerations as an example. This particularly applies to the common section of the Rhine, for which, since the beginning of the 19th century, all measures related to flood protection are bilaterally coordinated on the basis of a state contract. This joint position is among others found in the development concept for the Alpine Rhine presented in 2005.

[34] Document available under http://www.developpement-durable.gouv.fr/IMG/pdf/140509_SNGRIetAnnexes_approuvee_BAT_cle0459ad.pdf

Table: Internationally coordinated, overriding targets for flood risk management in the states of the IRBD Rhine

Overriding targets	**Austria**	**Liechtenstein**	**Switzerland**	**Germany (LAWA recommendations)**	**France**	**Luxembourg**	**Belgium (Wallonia)**	**Netherlands**
Avoid new, unacceptable risks (before a flood event)	X	X	X	X	(T)	X	X	(L) (T)
Reduce existing risks to an acceptable level (before a flood event)	X	X	X	X	(T)	X	X	(L) (T)
Reduce adverse consequences during a flood event	X	X	X	X	(T)	X	X	(L) (T)
Reduce adverse consequences after a flood (return of areas concerned to a normal state)	X	X	-	X	(T)	X	X	-
Legend: X: Overriding targets are explicitly mentioned (wordings partly differ) (T): Overriding targets are implicitly planned through other targets (L): Overriding targets are implicitly mentioned in Dutch law								

The table shows that, with respect to flood risk management, the general targets of the overriding Flood Risk Management Plan 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 Flood Risk Management Plans of the states and regions in the IRBD Rhine and partly in new targets. Generally, a distinction can be made between the following approaches:

- In Austria, the overriding objectives are not materialized in other targets but in a catalogue of measures. This catalogue of measures consists of 22 (types of) measures belonging to the fields of action of prevention, protection, awareness, preparedness and recovery. These fields of action completely cover the EU types of measures.
- In Germany, the overriding targets are further materialized in the federal states. The design depends on local needs.
    - In Baden-Württemberg the materializing targets for the Flood Risk Management Plans are taken from a catalogue of targets applicable to the entire Land. The Flood Risk Management Plans do not determine any more extensive targets.
    - In Bavaria, Rhineland-Palatinate, Hesse and North Rhine-Westphalia further targets are set for the federal states. However, in the areas of operation, these are adapted to the requirements or extended.
- In France, the national targets determined in the SNGRI are developed and extended in the Flood Risk Management Plans in specific targets for significant areas at risk (= Territoires à risques importants - TRI).
- In Switzerland, the targets generally concern the handling of floods. There is no particular planning targeted at the Flood Risk Management Directive.
- In the Netherlands, the targets are determined at a national scale for the following categories: prevention, protection and preparedness/crisis management. The measures are then linked to the targets.
- In Wallonia, technical committees have determined specific targets for each sub-basin. These take into account regional specificities (heavily populated sub-basins or increased danger of mudslides, heterogeneous sub-basin ...).

The links below lead to national or regional, detailed flood risk management plans in the IRBD Rhine.

Netherlands: http://www.helpdeskwater.nl/orbp

Germany: River basin community (FGG Rhein): http://www.fgg-rhein.de/servlet/is/87720/

France : http://www.lorraine.developpement-durable.gouv.fr/

Luxemburg: http://www.eau.public.lu/directive_cadre_eau/directive_inondation/index.html

Belgium (Wallonia): http://environnement.wallonie.be/inondations/

Liechtenstein: Information available under the following address: info.abs@llv.li

Austria: http://wisa.bmlfuw.gv.at / Fachthemen / Hochwasserrisikomanagement

Switzerland:

Strategy, targets and action principles

In the non EU Member State Switzerland the treatment of natural hazards is determined in the national "Strategy Protection against Natural Hazards" of the National Platform Natural Hazards (PLANAT). The national objectives and priorities for action are defined in a document published in 2011, "Living with Natural Hazards - Objectives and priorities for action of the Federal Office for the Environment (FOEN) in dealing with natural hazards" and are part of the planning for the legislation period 2011-2015 of the Swiss Federal Council.

- Strategy «Protection against Natural Hazards» of the National Platform for Natural Risks PLANAT http://www.planat.ch/en/marketing-materials-detail-view/datum/2012/10/08/strategie-naturgefahren-schweiz-3/ and http://www.planat.ch/en/marketing-materials-detail-view/datum/2013/10/17/sicherheitsniveau-fuer-naturgefahren-1/
- Plans for the legislation period 2011-2015 of the Swiss Federal Council http://www.bk.admin.ch/dokumentation/publikationen/00290/00878/index.html?lang=de
- Objectives and priorities for action of the Federal Office for the Environment (FOEN) in dealing with natural hazards: http://www.bafu.admin.ch/publikationen/publikation/01622/index.html?lang=en

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 http://www.bafu.admin.ch/publikationen/publikation/00804/index.html?lang=en
- the manual Programme Agreements concerning the Environment http://www.bafu.admin.ch/publikationen/publikation/01795/index.html?lang=de

Within supra-cantonal major projects development concepts fulfil a function comparable that to Management Plans in the EU. Examples:

- ***Alpine Rhine***
  http://www.alpenrhein.net/ > Development Concept Alpine Rhine
- ***Thur***
  R. Thur - A River with a Future for Man, Nature and Landscape. Thur cantons, Bundesamt für Geologie. 2001, Flood protection must create nature-near room for the river - in the

entire Thur catchment. Contract of riverine cantons. Explanations, problems and proposals for measures.

Links towards the level of areas of operation / sub-basins:

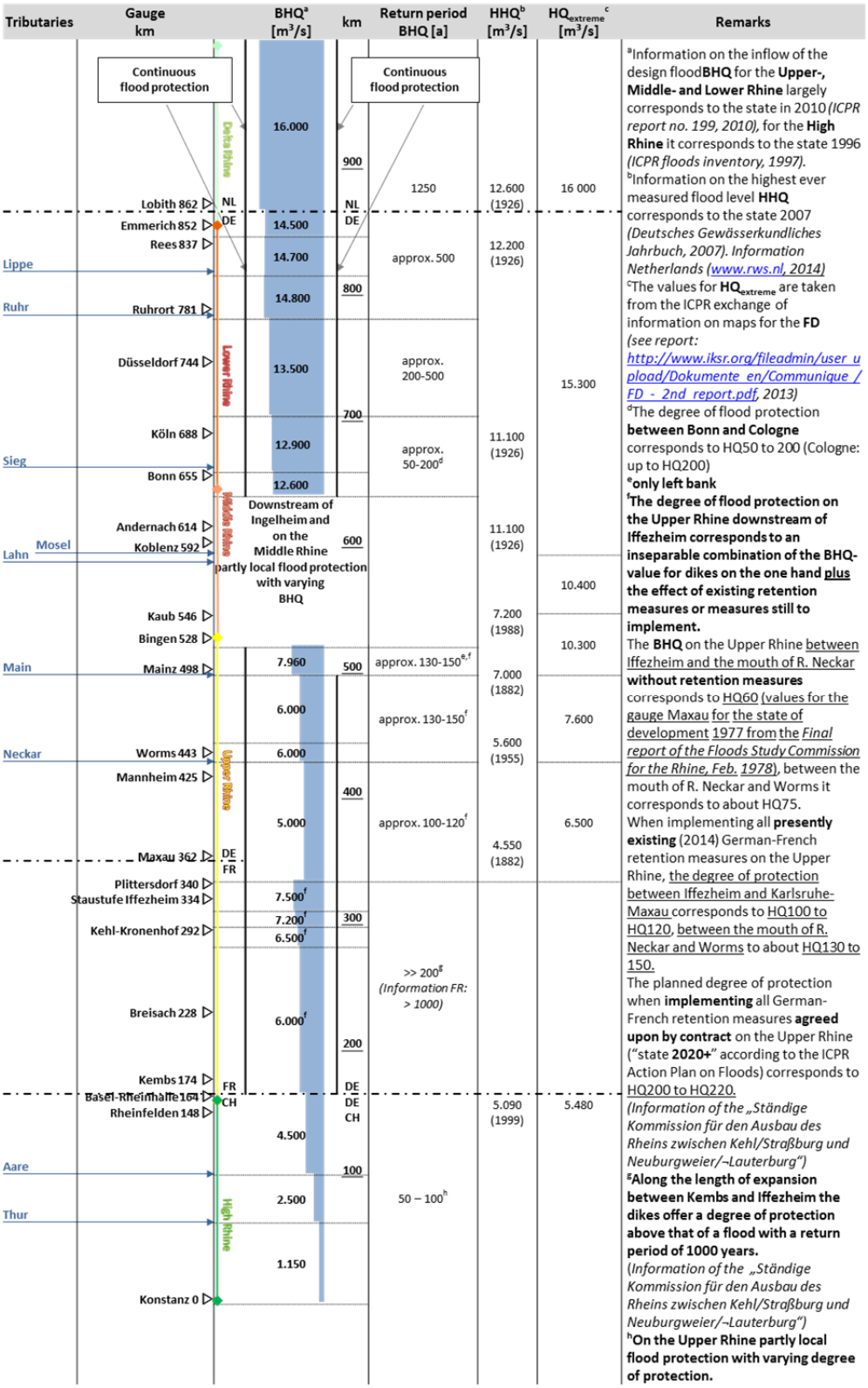
- **International Commission for the Protection of the Moselle and Saar (ICPMS):** http://www.iksms-cipms.org

Annex 5 - Information on the degree of flood protection along the Rhine

Section Alpine Rhine - Lake Constance

Country	Section	Level of protection (expressed in return periods) for the actual situation (2014) *e.g. 300 = flood with 300 years return period*
CH	**Alpine Rhine** Reichenau (for **Lake Constance:** Information see below "Lake Constance (Switzerland")) - Landquart	**Above 300, below 1000**
CH (small section in common with FL)	**Alpine Rhine** Landquart - Sargans	**Above 300, below 1000**
CH/FL	**Alpine Rhine**: Sargans - mouth R. Ill	**Above 1000; from km 60 lowering to 1000** (dams on both sides at equal height)
CH/AT	**Alpine Rhine** Mouth R. Ill - Lake Constance ("International section of the Rhine")	**100** (dams on both sides at equal height)
DE	**Lake Constance (Germany)**	**Partly local flood protection with varying degree of protection**
AT	**Lake Constance (Austria)**	
CH	**Lake Constance (Switzerland)**	

Section outlet of Lake Constance - Delta Rhine



Source: DE River Basin Community of the Rhine 2014, information of the NL/FR delegations, December 2014

Glossary:

Return period: Discharge with a certain probability of recurrence (in years: return period). A flood with a 100 years return period (HQ100) theoretically occurs on average once every 100 years, however, it may occur at any time and several times within a short period of time. These calculations are merely statistical. The discharge values of return periods are determined on a statistical basis (historic observations, model calculations, ...).

HQ: Flood discharge connected to a certain flood probability or return period (e.g. **$HQ_{Extreme}$** for an extreme flood event)

HHQ: Highest flood discharge ever measured

BHQ: Design flood or design discharge: The value of BHQ is the basis for dimensioning technical flood defences. The degrees of protection to achieve are determined by the choice of the annual probability of topping the design flood.

Annex 6 - Effects of climate change: Scenarios (until 2050) as bandwidth of changes in discharge (see ICPR strategy on adaptation to climate change, ICPR report no. 219)

Fields of action	Guidance value	Representative value	Relevant factor	Possible effects / scenarios (until 2050): Bandwidth (Basis for discussions on adaptation measures)
Flood risk management	**Level of protection / security**	**MHQ (in m³/s)**	Lobith: 6,680 m³/s (Dutch data)	0 to +20%
			Cologne: (MHQ year): 6,610 m³/s MHQ (hydrological summer, May-Oct.): 4,000 m³/s MHQ (hydrological winter, Nov. - Apr.): 6,510 m³/s	0 to +20%
			Kaub: (MHQ year): 4,370 m³/s MHQ (hydrological summer, May-Oct.): 3,240 m³/s MHQ (hydrological winter, Nov. - Apr.): 4,260 m³/s	-5 to +25%
			*Worms: (MHQ year): 3,480 m³/s MHQ (hydrological summer, May-Oct.): 2,870 m³/s MHQ (hydrological winter, Nov. - Apr.): 3,310 m³/s	-10 to +20%
			*Maxau: (MHQ year): 3,240 m³/s MHQ (hydrological summer, May-Oct.): 2,850 m³/s MHQ (hydrological winter, Nov. - Apr.): 2,980 m³/s	-5 to +15%
			*Basel: (MHQ year): 3,070 m³/s MHQ (hydrological summer, May-Oct.): 2,880 m³/s MHQ (hydrological winter, Nov. - Apr.): 2,520 m³/s	-5 to +10%
		HQ10 (in m³/s)	Lobith: 9,500 m³/s	-5 to +15%
			Cologne: 8,870 m³/s	-5 to +15%
			Kaub: 5,800 m³/s	-15 to +15%
			Worms: 4,750 m³/s	+7% (KLIWA)
			Maxau: 4,100 m³/s	0 to +5% (KLIWA)
			Basel: 3,980 m³/s	0 to +5% (KLIWA)
		HQ100 (in m³/s)	Lobith: 12,700 m³/s (BfG) - NL: 12,675 m³/s	Lobith: 0 to +20%
			Cologne: 12,000 m³/s	0 to +20%
			Kaub: 8,000 m³/s	-5 to +20%
			Worms: 6,000 m³/s (without use of retention facilities: 6,300 m³/s)	+5% (KLIWA; for HQ100 and HQ200)
			Maxau: 5,000 m³/s (without use of retention facilities: 5,300 m³/s)	0 to 5% (KLIWA; for HQ100 and HQ200)
			Basel: 4,780 m³/s	0 to 5% (KLIWA; for HQ100 and HQ200)
		HQextreme (in m³/s)	Lobith: 16,000 m³/s	Lobith: -5 to +20%
			Cologne: 15,250 m³/s (maximum consideration, no calculation value)	-5 to +25%
			Kaub: 10,400 m³/s	-5 to +25% *(no KLIWA data available)*
			*Worms: 7,600 m³/s (maximum possible discharge without considering dike breaches)	-15 to +30% *(no KLIWA data available)*
			*Maxau: 6,500 m³/s (maximum possible discharge without considering dike breaches)	-20 to +35% *(no KLIWA data available)*
			*Basel: 5,480 m³/s (defined as HQ1000)	-20 to +35% *(no KLIWA data available)*
	Navigation	**HSQ (in m³/s)** **HSW (in cm or m)**	Lobith: 5,675 m³/s	0 to +20% (trends for HQ100)
			Cologne: 830 cm = 6,960 m³/s	0 to +20% (trends for HQ100)
			Kaub: 640 cm = 5,100 m³/s	-5 to +20% (trends for HQ100)
			*Worms: 650 cm = 4,310 m³/s	+5% (KLIWA; trends for HQ100)
			*Maxau: 750 cm = 2,800 m³/s	+4% (KLIWA; trends for HQ100)
			*Basel to Rheinfelden: 2,500 m³/s	+3% (KLIWA; trends for HQ100)

Remark:
Luxemburg is not located along the main stream of the Rhine (no gauging stations indicated in the table above). All the same, certain adaptation measures have been carried out in water management.
Germany (gauging stations Kaub and Cologne): Further KLIWA-results are expected.
NL (Lobith):
- HQ100 (in m³/s): For Lobith, 0-10% seem to be more realistic (flooding of dikes).
-HQextreme (in m³/s) (according to Dutch statements, it is important to take HQextreme into consideration as a representative value): At Lobith, 6% are estimated for the increase of the relevant discharge by 2050.

*: For the gauges on the Upper Rhine at Basel, Maxau and Worms "no statement is possible" for possible climate effects on MHQ and HQextreme, as the bandwidth of modelling results is ≥ 50% and methodical deficits have been pointed out (see ICPR report no. 188, p. 17).
**: so far, the KLIWA project does not include any investigations for HQextrem)

Legend:

HQ10: Flood discharges with a probability of occurrence once in 10 years (highly probable floods).

HQ100: Flood discharges with a probability of occurrence once in 100 years (floods with average probability of occurrence).

HQextreme: Discharge during extreme floods (floods with low probability of occurrence).

MHQ: Arithmetic average of the highest daily discharge values during homogenous periods of time (e.g. hydrological half-year periods) of the period under consideration.

HSW: highest water level (in m)

HSQ: Discharge during highest navigable water level

Sources:

Data: "relevant factor": national data: Gauges in D: German delegation and BfG (Deutsches Gewässerkundliches Jahrbuch), Gauge in NL (Lobith): NL-Delegation, Gauge in CH (Basel): CH-Delegation

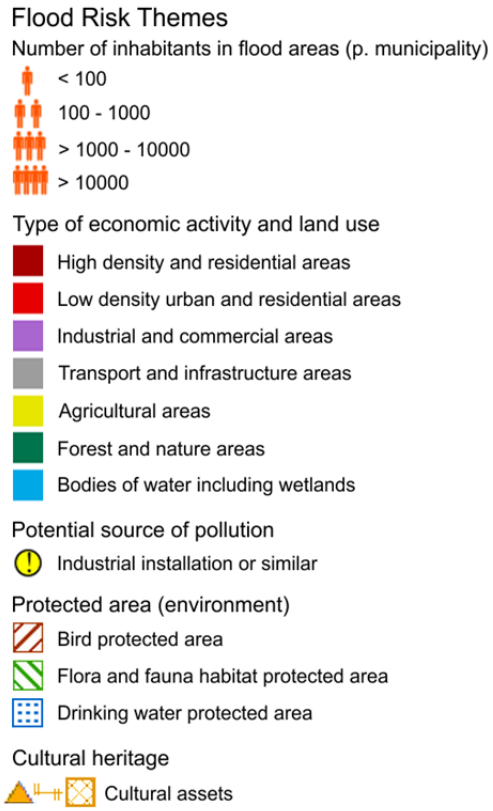
Data "Climate Effects (...)":
- ICPR report no. 188, 2011
- Results KLIWA project, state September 2014

Annex 7 - Internet links towards flood hazard and flood risk maps including the ICPR Atlas of the Rhine 2015

ICPR:
Report on the Drafting of Flood Hazard and Flood Risk Maps in the International River District Rhine:
http://www.iksr.org/en/hochwasserrichtlinie/hochwassergefahrenkarten-und-risikokarten/index.html

Interactive Rhine Atlas 2015 (Flood maps of the international river basin district Rhine): http://www.iksr.org/en/dokumentearchiv/rheinatlas/index.html

Legend for the Rhine Atlas 2015:



Netherlands: http://www.risicokaart.nl/en/

Germany:

- **North Rhine-Westphalia:**
  http://www.flussgebiete.nrw.de/index.php/HWRMRL/Risiko-_und_Gefahrenkarten
- **Rhineland-Palatinate: Rhineland-Palatinate** makes use of **Article 13, par. 1a** for all areas of operation in the IRBD Rhine.
  Interactive flood hazard and flood risk maps:
  http://www.hochwassermanagement.rlp.de/servlet/is/8662/
- **Hesse:** Interactive WEB-GIS map viewer concerning flood hazard and flood risk maps:
  http://hwrm.hessen.de
- **Baden-Württemberg:**
  www.hochwasserbw.de
  Map viewer: http://udoprojekte.lubw.baden-wuerttemberg.de/udoprojekte/alias.xhtml?alias=hwgk_uf
- **Saarland:** http://geoportal.saarland.de/portal/de/fachanwendungen/wasser.html
- **Bavaria:**
  For the Bavarian share of the area of operation Main, Bavaria makes use of FD **Article 13, Par. 1b and Article 13, Par. 3**.

Information on drafting flood hazard maps/flood risk maps:
http://www.lfu.bayern.de/wasser/hw_risikomanagement_umsetzung/hwgk_und_hwrk/index.htm
Maps for the Coordination Area Main: http://www.iksr.org

- **Lower Saxony:** www.hwrm-rl.niedersachsen.de (particularly R. Vechte and R. Dinkel). Certain sections: no significant risks.
- **Thuringia:** http://www.tlug-jena.de/hwrm

France: The drafting of the maps of areas exposed to significant flood risks in 2013 and 2014 includes a hearing of local authorities in order to take into account their remarks.
http://www.lorraine.developpement-durable.gouv.fr/

Luxemburg: http://eau.geoportail.lu/?lang=en

Belgium (Wallonia): On 19 December 2012 the Wallonian government adopted the drafted maps (in particular for R. Sure and Our). The definite maps which will be part of the Flood Risk Management Plan will be adopted after the public hearing in 2015 at the same time as the Flood Risk Management Plans. These maps are available on the Wallonian geoportal:
http://geoapps.wallonie.be/inondations
General internet page: http://environnement.wallonie.be/inondations/

Liechtenstein: Information available under the following address: info.abs@llv.li

Austria: http://wisa.lebensministerium.at/ > Wasser Karten > Hochwasser

Switzerland:
State of risk mapping
http://map.bafu.admin.ch/ > Natural hazards > state of natural hazard mapping
Hazard maps:
http://www.bafu.admin.ch/gefahrenkarten
http://www.bafu.admin.ch/cartes-dangers
http://www.bafu.admin.ch/carte-pericoli

International Commission for the Protection of the Moselle and Saar (ICPMS):
http://www.iksms-cipms.org

Area of operation High Rhine (joint report):
"Rhine River Basin District - Area of Operation High Rhine: International Information and Coordination when Implementing the EU Floods Directive:
- Preliminary Flood Risk Assessment and Delimitation of Risk Areas
- Drafting Flood Hazard and Flood Risk Maps"

http://www4.um.baden-wuerttemberg.de/servlet/is/110808/20131018_Koordinationsbericht_BG_Hochrhein_HWRM.pdf

Annex 8 - Possible synergies between measures of the Floods Directive and measures of the Water Framework Directive (e.g. FRMP of Moselle-Sarre)

HOCHWASSERRISIKOMANGEMENTPLAN MOSEL-SAAR (IKSMS) - PLAN DE GESTION MOSELLE-SARRE (CIPMS) - OVERSTROMINGSRISICOBEHEERPLAN MOEZEL-SAAR (IKSMS)
Types de mesures / Maßnahmentypen / Types van maatregelen (Version/versie: IH02_2014_rev16102014)

Légende / Legende

	Coordination requise à l'échelle internationale / *Internationale Koordinierung erforderlich / Internationale coördinatie vereist*
	Echange d'informations requis à l'échelle internationale / *Internationaler Informationsaustausch erforderlich / Internationale informatie-uitwisseling vereist*
	Aucune coordination requise à l'échelle internationale / *Keine internationale Koordinierung erforderlich / Geen internationale coördinatie vereist*
+	type de mesure de la DI ayant un effet potentiel positif sur les objectifs environnementaux de la DCE (M1 selon la LAWA*) / *Maßnahmentyp der HWRM-RL mit potenziell positiven Auswirkungen auf die Umweltziele der WRRL (M1 nach LAWA*) / Type ROR-maatregel met een potentieel positief effect op de KRW-milieudoelstellingen (M1 conform LAWA*)*
!	type de mesure de la DI pouvant avoir un effet potentiel négatif sur les objectifs environnementaux de la DCE et devant faire l'objet d'un examen au cas par cas pour analyser la situation et si besoin résoudre ou atténuer l'impact environnemental de la mesure sur la qualité des milieux aquatiques (M2 selon la LAWA*) / *Maßnahmentyp der HWRM-RL mit potenziell nachteiligen Auswirkungen auf die Umweltziele der WRRL, daher Einzelfallprüfung und ggf. Beseitigung oder Abmilderung der Umweltauswirkung der Maßnahme auf die aquatischen Lebensräume erforderlich (M2 nach LAWA*) / Type ROR-maatregel met een potentieel negatief effect op de KRW-milieudoelstellingen dat per geval moet worden onderzocht en waarvan het effect op het aquatisch milieu eventueel moet worden opgeheven of gemitigeerd (M2 conform LAWA*)*
0	type de mesure de la DI sans effet potentiel sur les objectifs environnementaux de la DCE (M3 selon la LAWA*) / *Maßnahmentyp der HWRM-RL ohne potenzielle Auswirkungen auf die Umweltziele der WRRL (M3 nach LAWA*) / Type ROR-maatregel zonder potentieel effect op de KRW-milieudoelstellingen (M3 conform LAWA*)*

* LAWA Bund/Länder-Arbeitsgemeinschaft Wasser: Recommandations concernant la mise en œuvre coordonnée de la DI et de la DCE - Synergies potentielles au niveau des mesures, de la gestion des données et de la participation du public // *Empfehlungen zur koordinierten Anwendung der EG-HWRM-RL und EG-WRRL - Potenzielle Synergien bei Maßnahmen, Datenmanagement und Öffentlichkeitsbeteiligung // Aanbevelingen voor de gecoördineerde implementatie van de EG-ROR en de EG-KRW – potentiële synergie-effecten op het gebied van maatregelen, gegevensbeheer en publieksparticipatie*

Aspects of flood risk management	Aspects de la gestion du risque d'inondation	Aspekte des Hochwasserrisikomanagements	Besoin de coordination ou d'échange d'informations // *Bedarf an Koordinierung oder Informationsaustausch*	Interactions DCE / DI // *Wechselwirkung HWRM-RL / WRRL*
No Action	Pas d'action	Keine Maßnahmen		
1. Prevention	**1. Prévention**	**1. Vermeidung**		
1.1. Avoidance	***1.1. Evitement***	***1.1. Vermeidung***		
Measure to prevent the location of new or additional receptors in flood prone areas	Mesure pour éviter la localisation de nouveaux enjeux ou d'enjeux supplémentaires dans des zones inondables	Maßnahme zur Vermeidung der Ansiedlung neuer oder zusätzlicher Rezeptoren in hochwassergefährdeten Gebieten		+
a) Land use planning policies	a) Politiques de planification	a) Landnutzungsplanung		+
b) Land use regulation	b) Règlements de l'occupation des sols	b) Landnutzungsbeschränkungen		+
1.2. Removal or relocation	***1.2. Suppression ou déplacement***	***1.2. Entfernung oder Verlegung***		
a) Relocate receptors to areas of lower probability of flooding and / or of lower hazard	a) Déplacement des enjeux vers des zones à probabilité d'inondation plus faible et/ou à risque plus faible	a) Verlegung von Rezeptoren in Gebiete mit niedrigerer Hochwasserwahrscheinlichkeit und / oder mit geringeren Gefahren		+
b) Remove receptors from flood prone areas	b) Suppression des enjeux d'une zone inondable	b) Entfernung / Rückbau von Rezeptoren aus hochwassergefährdeten Gebieten		+
1.3. Reduction	***1.3. Réduction***	***1.3. Verringerung***		
adapt receptors to reduce the adverse consequences in the event of a flood : actions on buildings, public networks, etc.	Mesures pour adapter les enjeux afin de réduire les conséquences négatives en cas d'inondation : actions sur les bâtiments, réseaux publics, etc	Maßnahme zur Anpassung der Rezeptoren, um die nachteiligen Folgen im Falle eines Hochwasserereignisses zu verringern, Maßnahmen an Gebäuden, öffentlichen Netzwerken usw..		0
1.4. Other prevention	***1.4. Autres mesures***	***1.4. Sonstige Vorbeugungs-maßnahmen***		
Other measure to enhance flood risk prevention	Autres mesures pour améliorer la prévention du risqué d'inondations	Sonstige Maßnahmen zur Unterstützung der Vermeidung von Hochwasserrisiken		
a) Maintenance programmes or policies	a) Programmes ou politiques de maintenance	a) Erhaltungsprogramme oder –maßnahmen		0
b) Flood vulnerability assessment	b) Évaluation de la vulnérabilité	b) Bewertung der Anfälligkeit für Hochwasser		0
c) Flood risk modelling and assessment	c) Modélisation et évaluation des risques d'inondation	c) Modellierung und Bewertung von Hochwasserrisiken		0
2. Protection	**2. Protection**	**2. Schutz**		
2.1. Natural flood management / runoff and catchment management	***2.1. Gestion naturelle des inondations / gestion des écoulements et de la rétention***	***2.1. Management natürlicher Überschwemmungen / Abfluss- und Einzugsgebietsmanagement***		
Measures to reduce the flow into natural or artificial drainage systems, such as overland flow interceptors and / or storage, enhancement of infiltration, etc and including in-channel, floodplain works and the reforestation of banks, that restore natural systems to help slow flow and store water	Mesures pour réduire le débit dans le réseau hydrographique naturel ou artificiel telles que l'interception et / ou le stockage en surface, l'augmentation de l'infiltration, etc. y compris travaux dans lit mineur et lit majeur et reboisement des rives qui aident à ralentir les écoulements et à retenir l'eau.	Maßnahmen zur Reduzierung des Abflusses in natürliche und künstliche Entwässerungssysteme, wie Sammel- und / oder Speicherbecken für oberirdischen Abfluss, Verbesserung der Infiltration usw. einschließlich von in Überschwemmungsgebieten und in Gewässern vorhandenen Anlagen und der Wiederaufforstung von Böschungen zur Wiederherstellung natürlicher Systeme, die dazu beitragen, den Abfluss zu verzögern und Wasser zu speichern.		+
2.2 Water flow regulation	***2.2. Régulation du débit***	***2.2. Regulierung des Wasserabflusses***		
Physical interventions to regulate flows which have a significant impact on the hydrological regime	Mesures comprenant les interventions physiques pour réguler le débit qui ont un impact significatif sur le régime hydrologique	Maßnahmen, die sich signifikant auf das hydrologische Regime auswirken; diese umfassen anlagenbedingte Eingriffe für die Abflussregulierung		!
a) Construction, modification or removal of water retaining structures (e.g., dams or other on-line storage areas)	a) Construction, modification ou suppression d'ouvrages de rétention des eaux (par exemple barrages ou autre zone de stockage en ligne	a) Baumaßnahmen, Änderung oder Beseitigung von Wasser zurückhaltenden Strukturen (z. B. Dämme oder andere angeschlossene Speichergebiete)		!
b) Development of existing flow regulation rules	b) Développement des règles existantes de régulation du débit	b) Weiterentwicklung bestehender Vorgaben zur Abflussregulierung		!
2.3 Channel, Coastal and Floodplain Works	***2.3. Travaux en cours d'eau, sur les côtes et dans le lit majeur***	***2.3. Anlagen im Gewässerbett, an der Küste und in Überschwemmungsgebieten***		
Physical interventions in freshwater channels, mountain streams, estuaries, coastal waters and flood-prone areas of land	Mesures comprenant les interventions physiques dans le lit de cours d'eau, les torrents de montagne, les eaux côtières et les zones inondables comme la construction, modification ou suppression d'ouvrages ou la modification du lit, gestion dynamique des sédiments, digues, etc.	Maßnahmen, die anlagebedingte Eingriffe in Süßwassergerinnen, Gebirgsflüssen, Ästuaren, Küstengewässern und hochwassergefährdeten Gebieten beinhalten, wie der Bau, Änderungen oder die Beseitigung von Bauwerken oder Änderungen von Gerinnen, dem Management der Sedimentdynamik, von Dämmen und Deichen.		!
2.4 Surface water management	***2.4 Gestion des eaux de surface***	***2.4. Management von Oberflächengewässern***		
Physical interventions to reduce surface water flooding, typically, but not exclusively, in an urban environment, such as enhancing artificial drainage capacities or though sustainable drainage systems (SuDS).	Mesures comprenant les interventions physiques pour réduire les inondations par ruissellement typiquement mais pas exclusivement dans un environnement urbain en améliorant les capacités artificielles de drainage ou au travers de système de drainage durables	Maßnahmen, einschließlich anlagebedingter Eingriffe, zur Reduzierung von Überschwemmungen durch Oberflächengewässer, typischerweise aber nicht ausschließlich, in städtischen Gebieten, wie zum Beispiel Steigerung der künstlichen Entwässerungskapazität oder durch den Bau nachhaltiger Entwässerungssysteme (SuDS).[1]		0
2.5 Other protection	***2.5 Autres mesures***	***2.5. Sonstige***		
Flood defence asset maintenance programmes or policies	Programmes ou politiques de maintenance des équipements de défense contre les inondations	Programme oder Konzepte zur Instandhaltung bestehender Hochwasserschutzeinrichtungen		!
3 Preparedness	**3. Préparation**	**3. Vorsorge**		
3.1. Flood forecasting and warning	***3.1. Prévision et annonce de crues***	***3.1. Hochwasservorhersagen und - warnungen***		
Establish or enhance a flood forecasting or warning system	Mesures pour mettre en place ou améliorer les systèmes de prévision ou d'annonce de crue	Maßnahme zur Einrichtung bzw. Verbesserung von Hochwasservorhersage- oder –warndiensten.		0
3.2. Emergency Event Response Planning / Contingency planning	***3.2. Plan de gestion de crise / catastrophe***	***3.2. Planung von Hilfsmaßnahmen für den Notfall / Notfallplanung***		
Establish or enhance flood event institutional emergency response planning	Mesures pour établir ou améliorer les plans officiels de secours en cas d'inondation	Maßnahme zur Einrichtung oder Verbesserung von institutionellen Notfallplänen für den Fall von Hochwasserereignissen.		0
3.3. Public Awareness and Preparedness	***3.3. Prise de conscience et préparation du grand public***	***3.3 Öffentliches Bewusstsein und Vorsorge***		
Establish or enhance the public awareness or preparedness for flood events	Mesures pour réaliser ou améliorer la prise de conscience et préparation du grand public en cas de crue	Maßnahme zur Bildung und Stärkung des öffentlichen Bewusstseins bzw. der öffentlichen Vorsorge im Fall von Hochwasserereignissen		0
3.4. Other preparedness	***3.4. Autres préparation***	***3.4. Sonstige Vorsorge***		
Other measure to establish or enhance preparedness for flood events to reduce adverse consequences	Autre mesure pour établir ou améliorer la préparation en cas d'épisodes de crues et pour réduire les conséquences négatives	Sonstige Maßnahme zur Einrichtung oder Verbesserung der Vorsorge bei Hochwasserereignissen zur Verminderung nachteiliger Folgen		0
4. Recovery and review	**4. Remise en état et retour d'expérience/ réexamen**	**4. Wiederherstellung / Regeneration und Überprüfung**		
4.1. Individual and societal recovery	***4.1. Remise en état individuelle et collective***	***4.1. Überwindung der Folgen für den Einzelnen und die Gesellschaft***		
Clean-up and restoration activities (buildings, infrastructure, etc.)	Nettoyage et restauration des activités (bâtiments, infrastructures, etc.)	Aufräum- und Wiederherstellungsaktivitäten (Gebäude, Infrastruktur, etc.)		0
Health and mental health supporting actions, incl. managing stress	Actions de soutien psychologique et sanitaire (y compris gestion du stress)	Unterstützende Maßnahmen zur körperlichen Gesundheit und dem geistigen Wohlbefinden, einschl. Stressbewältigung		0
Disaster financial assistance (grants, tax), incl. disaster legal assistance, disaster unemployment assistance	Aide financière en cas de catastrophe (aides, impôts) y compris aide légale en cas de catastrophe, indemnisation en cas de chômage	Finanzielle Katastrophenhilfe (Zuschüsse, Steuern), einschließlich juristischer Unterstützung und Arbeitslosenunterstützung im Katastrophenfall		0
Temporary or permanent relocation	Relogement temporaire ou permanent	Zeitweilige oder dauerhafte Umsiedlung		0
Other	Autre	Sonstiges		0
4.2. Environmental recovery	***4.2. Réparation des dommages environnementaux***	***4.2. Beseitigung von Umweltschäden / Regeneration***		
Clean-up and restoration activities (with several sub-topics as mould protection, well-water safety and securing hazardous materials containers)	Opérations de nettoyage et de restauration (avec différents sous-chapitres comme la protection contre la boue/moisissure, la sécurité des puits de prélèvement d'eau potable, la sécurisation du stockage des substances dangereuses)	Aufräum- und Wiederherstellungsaktivitäten (mit verschiedenen Unterpunkten wie Schutz gegen Schimmelpilze, Sicherheit von Brunnenwasser, Sicherung von Gefahrstoffbehältern)		+
4.3. Other recovery and review	***4.3. Autre remises en état***	***4.3. Sonstige Wiederherstellung / Regeneration und Überprüfung***		
Lessons learnt from flood events	Leçons apprises des épisodes de crue	Erfahrungen aus Hochwasserereignissen		+
Insurance policies	Polices d'assurance	Versicherungsstrategien		0
Other	Autre	Sonstige		0
5. Other	**5 Autres**	**5. Sonstige**		**pas possible/ *nicht möglich***

[1] Vgl. 2.3
Problème de traduction en français
Übersetzungsproblem im Französischen

Annex 9 - Connection with the implementation of other EU Directives mentioned

Partly, the measures of the management plan according to the Water Framework Directive (WFD) and according to the Flood Risk Management Plan following the Floods Directive serve the same target. The measures under the Flood Risk Management Plan reduce damage caused by floods and thus often also damage to nature and the environment. The measures of both plans may support one another along big rivers where more room for the river contributes to flood risk management and enhances the quality of the natural system. This particularly applies to all measures retaining water in the entire catchment and along the Rhine and which locally enhance natural seepage. This serves the renaturing of rivers, the reactivation of floodplains, the extensification in agriculture, nature development, afforestation and desealing.

With respect to these issues please refer to the table of measures in Annex 6 indicating eventual synergies between measures under the Floods Directive and those under the WFD.

Flood areas or floodplains are essential for the Rhine ecosystem, but also for man. They enhance water retention and act as natural flood basins. By reactivating overbank areas along the Rhine, further habitats for the flora and fauna living in the water, on its banks and in the floodplains will be opened up. The figure below informs on the renaturing of floodplains along the Rhine between 2000 and 2012 and also includes shares of controllable flood retention areas which may be subject to ecological flooding and thus develop towards floodplains.

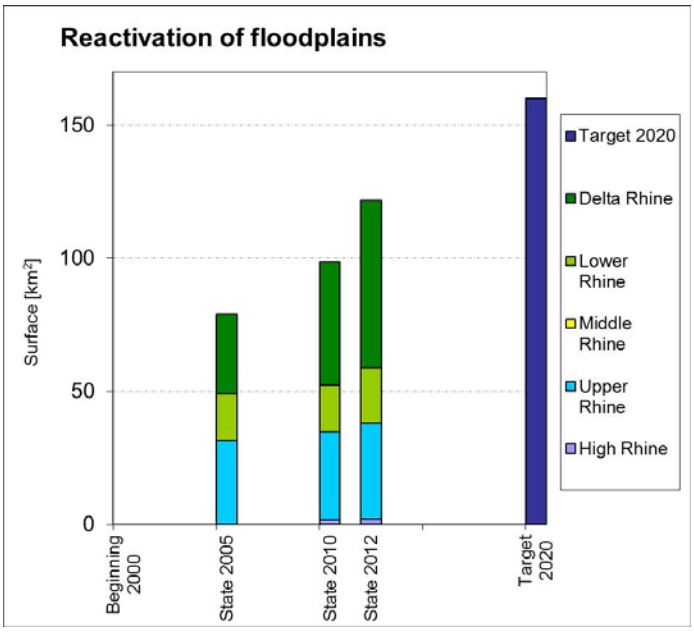


Figure: Reactivation of floodplains along the Rhine between 2000 and 2012;
Source: ICPR (2013): The Rhine and its catchment – a survey

Flood risk management is interacting with further EU politics in the fields of water management, nature protection, agriculture etc. and particularly the Water Framework Directive. With respect to sustainability, the target is to exploit the potential of synergies regarding the environmental targets of the Water Framework Directive and thus to grant an efficient and wise use of resources. Within a "win-win" approach, flood risk management enhances the targets of environment protection and vice versa.

Wherever possible, this linking of flood prevention measures with ecological enhancement should be maintained in future actions and approaches.

When precise measures achieve a certain volume, the initiating agents are legally obliged to carry out an environmental impact assessment. This is true of many measures within the framework of both directives. Drafting a national environmental impact assessment may contribute to an integrated design of measures[35]

[35] The EU Resource Document "Links between the Floods Directive (FD 2007/60/EC) and Water Framework Directive (WFD 2000/60/EC)" summarizes the required coordination of both directives and gives national examples.

Annex 10 - Internet pages of the flood forecasting and flood announcement centres

ICPR:
http://www.iksr.org/en/themen/hochwasser/melde-und-vorhersagezentralen/index.html
Map: http://www.iksr.org/en/themen/hochwasser/melde-und-vorhersagezentralen/interaktive-karte/index.html

Netherlands:
Rijkswaterstaat Water Management Centrum Nederland:
http://www.rws.nl/kaarten/waterstand-tov-nap.aspx
http://www.rijkswaterstaat.nl/water/waterdata-en-waterberichtgeving/waterberichten/waterbericht/index.aspx
ICPR presentation page: http://www.iksr.org/en/themen/hochwasser/melde-und-vorhersagezentralen/rws-wmcn-lelystad/index.html

Germany:
German Rhine and its tributaries: Flood Warning Centre Rhine (HMZ) in Mainz:
http://www.hochwasser-rlp.de/
ICPR presentation page: http://www.iksr.org/en/themen/hochwasser/melde-und-vorhersagezentralen/hmz-mainz/index.html

Baden-Württemberg: Flood forecasting centre (HVZ)
Baden-Württemberg
http://www.hvz.baden-wuerttemberg.de/
ICPR presentation page: http://www.iksr.org/en/themen/hochwasser/melde-und-vorhersagezentralen/hvz-karlsruhe/index.html

France : Flood forecasting service Rhine-Sarre (Service de Prévision des Crues SPC Rhin-Sarre)
http://www.vigicrues.gouv.fr/
ICPR presentation page: http://www.iksr.org/en/themen/hochwasser/melde-und-vorhersagezentralen/spc-rhein-saar/index.html

Switzerland: Forecasting centre of the Bundesamt für Umwelt BAFU in Bern
http://www.hydrodaten.admin.ch/d/
ICPR presentation page: http://www.iksr.org/en/themen/hochwasser/melde-und-vorhersagezentralen/bafu-bern/index.html

Lake Constance (DE, AT, CH): http://www.bodensee-hochwasser.info/

Austria (Vorarlberg): http://www.vorarlberg.at/abfluss/

Liechtenstein: BAFU is taking over flood warning for Liechtenstein: http://www.natural-hazards.ch or http://www.hydrodaten.admin.ch/en/warnkarte_national.html or in detail http://www.hydrodaten.admin.ch/en/messstationen_vorhersage.html

Belgium: http://voies-hydrauliques.wallonie.be/opencms/opencms/fr/hydro/Actuelle/crue/index.html

Luxemburg: http://www.inondations.lu

Moselle-Sarre http://www.iksms-cipms.org/servlet/is/3109/

Annex 11-1 - Retention measures between Basel and Lobith and corresponding volumes (in million m³)

Rhine km	Area	Country/ federal state	Location of measure	Type of measure	Volume ready for use [Mio. m³]				
					1995	2005	2014	2020[4]	2020+[5]
174 - 226 234 - 291	Upper Rhine	F	Grand Canal d'Alsace and loops	Special operating mode/maneuvre operation of hydroelectric power plants on the Rhine	45	45	45	45	45
174.6 – 219		D-BW	Weil-Breisach	Lowering the flood plain				2.8[2]	25
224,8		D-BW	Breisach	Retention operating mode agricultural weir				9,3	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 operating mode 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	Relocation of dike			4,2	4,2	4,2
				Retention polder			13,8	13,8	13,8
377		D-RP	Hördt	Reserved area					35
381,3		D-BW	Elisabethenwört	Retention polder/ Relocation of dike					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	Relocation of dike				1,2	1,2
				Retention polder				7,8	7,8
436		D-RP	Petersau-Bannen	Relocation of dike				1,4	1,4
439		D-RP	Worms, Mittlerer Busch	Relocation of dike			2,1	2,1	2,1
440,2		D-RP	Worms Bürgerweide	Relocation of dike		2	2	2	2
467,3		D-RP	Eich	Relocation of dike		0,4	0,4	0,4	0,4
468,5		D-RP	Eich	Reserved area					22,6
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	Retention polder					10
760,5		D / NRW	Mündelheim	Relocation of dike				5	5
802		D / NRW	Orsoy	Relocation of dike		10	10	10	10
797,5		D / NRW	Orsoy	Retention polder				22	22
818,5		D / NRW	Bislicher Insel[3]	Relocation of dike	50	50	50	50	50
832,5		D / NRW	Lohrwardt	Relocation of dike				13	13
850		D / NRW	Bylerward	Retention polder					36
Global retention volume of measures lowering the water level of the Rhine per state of development					***160.3[1]***	***211,6***	***251***	***349,2***	***535,2***

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

[2] 2.8 million m³ = section 1 of all 4 sections. Additionally, in 2020, parts of sections III and IV will be accomplished.

[3] During floods of the Rhine, the Daxlander Au and Bislicher Insel were already flood areas before the measures were accomplished.

[4] A number in column 2020 does not in all cases mean that the measure is accomplished. In all cases, approval procedures have begun.

[5] 2020+ = after 2020 and according to plans until about 2030

Annex 11-2 - 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).

River km	Area	Country	Location of measure	Type of measure	Minimal requirement concerning the lowering of the water level[1] (per measure) (cm)				
					1995	2005	2014[2]	2020	2020+
865	Bovenrijn/Waal/Merwedes	NL	Rijnwaarden	Lowering the flood plain				11	11
871		NL	Millingerwaard (PKB)	Removing obstacles				9	9
871		NL	Millingerwaard (NURG)	Lowering the flood plain					
871		NL	Suikerdam	Removing obstacles				8	8
878		NL	Bemmel	Lowering the flood plain			5	5	5
882		NL	Lent	Relocation of dike				27	27
897		NL	Afferdensche and Deestsche Waard	Lowering the flood plain				6	6
867		NL	Waalbochten	Lowering of groynes				8	8
887		NL	Midden-Waal	Lowering of groynes			12	12	12
916		NL	Waal Fort St. Andries	Lowering of groynes				8	8
934		NL	Beneden Waal	Lowering of groynes				6	6
948		NL	Munnikenland	Lowering the flood plain				11	11
955		NL	Avelingen	Lowering the flood plain			5	5	5
964		NL	Noordwaard	Depoldering				30	30
968		NL	Noordwaard (NOP)	Lowering the flood plain			17	17	17
871	Pannerdensch Kanaal, Nederrijn, Lek	NL	Huissen	Lowering the flood plain				8	8
883		NL	Meinerswijk	Lowering the flood plain			7	7	7
893		NL	Doorwerthsche Waarden	Lowering the flood plain			2	2	2
898		NL	Renkumse Benedenwaard	Lowering the flood plain			18	18	18
898		NL	Veerstoep Lexkesveer	Removing obstacles					
908		NL	Middelwaard	Lowering the flood plain			3	3	3
911		NL	De Tollewaard	Lowering the flood plain			6	6	6
917		NL	Machinistenschool Elst	Removing obstacles			5	5	5
946		NL	Vianen	Lowering the flood plain				6	6
878	IJssel	NL	Hondsbroekse Pleij	Relocation of dike			46	46	46
918		NL	Cortenoever	Relocation of dike				35	35
930		NL	Voorster Klei	Relocation of dike				29	29
943		NL	Bolwerksplas	Lowering the flood plain				17	17
947		NL	Keizerswaard	Lowering the flood plain				10	10
957		NL	Fortmonder- and Welsumerwaarden	Lowering the flood plain				6 - 8	6 - 8
961		NL	Veessen-Wapenveld	High water channel				63	63
977		NL	Scheller and Oldenelerwaarden	Lowering the flood plain				8	8
978		NL	Spoorbrug Zwolle	Removing obstacles				6	6
980		NL	Westenholte	Relocation of dike				15	15
980		NL	Westenholte	Deepening the summer bed				29	29

[1] Above all, these measures aim at increasing the discharge capacity of the Rhine delta. Therefore, only the targeted lowering of water level per measure is indicated. These measures are thus not taken into account in the global indication of the retention volume.
PKB = Planologische Kernbeslissing (planning approval process)
NURG = Nadere Uitwerking Rivierengebied (detailed development of the river basin)
NOP = Natuurontwikkelingsproject (nature development project)

[2] Measures concerning flood safety operational by end 2014 (source: 24e voortgangsrapportage Ruimte voor de Rivier, Rita Lammersen, Nov. 2014)

Annex 12 - Assessment of the modification of probability due to measures aimed at reducing flood levels along the Rhine (Summary ICPR report no. 229; see here, no English version available)

Remark concerning the use of the results for other problems: The results presented are those of specific ICPR questions. With respect to other problems it must be checked in depth, whether these results, their method and validity may be used for other applications (e.g. cost-benefit-analysis).

On 22 January 1998 the 12th Conference of Rhine Ministers adopted the "Action Plan on Floods" for the Rhine. This Action Plan states the following action targets:

- Reduction of damage risks
- Reduction of flood levels
- Increase flood awareness
- Improve the flood warning system

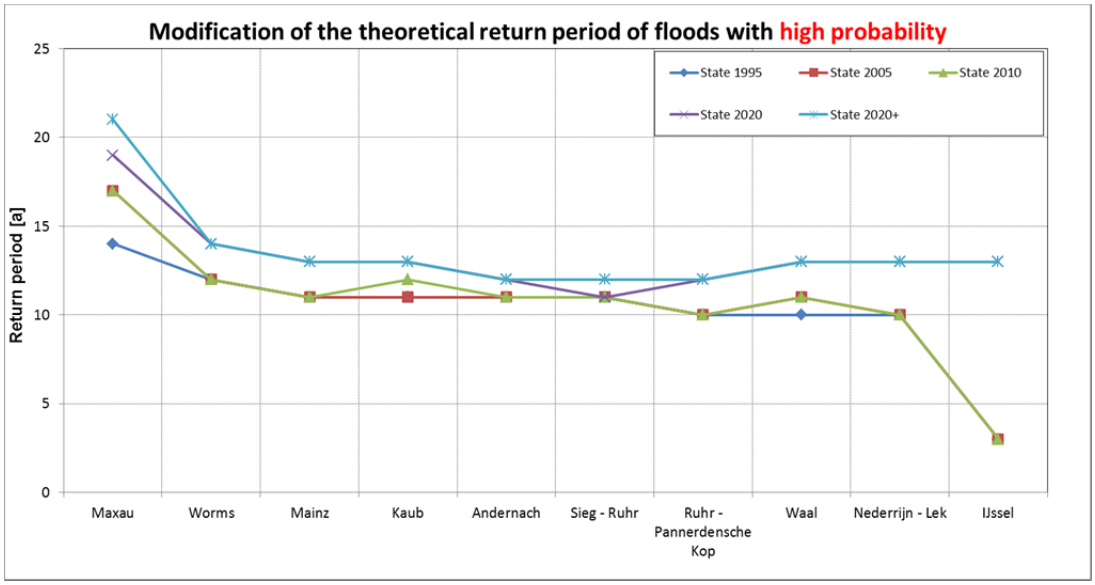
In the Action Plan on Floods, the target "Reduction of flood levels due to measures on the Rhine" is defined as "Reduction of extreme flood levels by up to 60[36] cm by 2020 downstream the impounded section". 1995 is used as reference state.

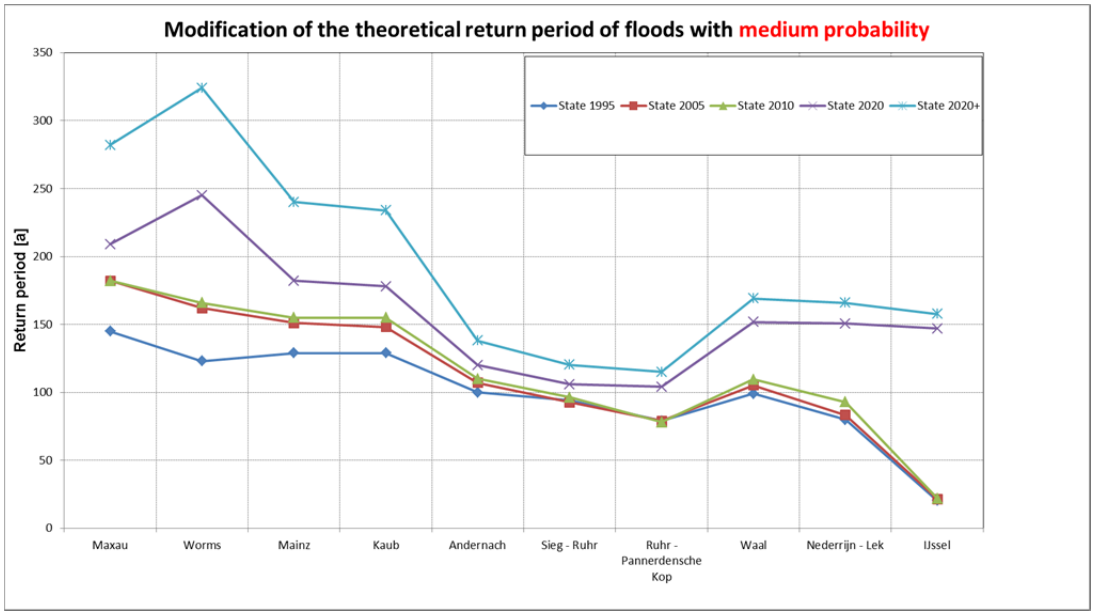
Within the framework of the evaluation in 2010, the ICPR expert group "Validation" (EG HVAL) examined the effect of retention measures of the Action Plan on Floods along the Rhine for the development conditions of the Rhine in 1977[37], 1995, 2005, 2010, 2020 and "2020plus[38]" (see list and map of the measures implemented under further development conditions as indicated in Annex 4 and 5). The results are included in the final report (ICPR, 2012a) (see this link: http://www.iksr.org/uploads/media/199_d.pdf (no English version available)).

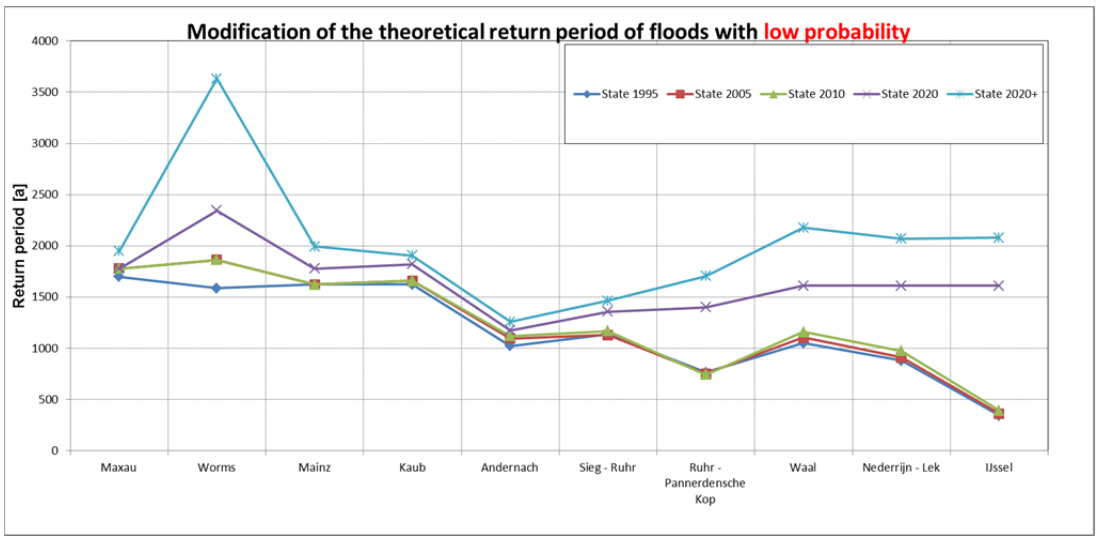
The task of the ICPR expert group HIRI (Flood risks) is to evaluate within the Action Plan on Floods, in how far the damage risk has changed along the Rhine since 1995 (action target "Reduction of damage risks") and to analyse within the Flood risk management directive of the European Community (EC FD) how measures influence the flood risk. These calculations are based on national flood hazard maps (and flood risk maps) for 3 flood scenarios according to the Floods Directive to which a modification of probability is assigned following the implementation of measures of the Action Plan on Floods concerning the reduction of flood levels.

Therefore, the evidence concept of the HVAL expert group of April 2009 decided to equally investigate into modifications of flood probability due to measures of the Action Plan on Floods and to make the results available for the HIRI expert group. The following figures and Table 1 represent the results for the development stages investigated into at the different Rhine gauging stations or along stretches of the Rhine.

[36] Reduction of flood levels - Reduction of 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)
[37] In general, the indications concerning flood probabilities concern the development condition 1977 (= end of the development of the Upper Rhine and the construction of barrages).
[38] Measures of the Action Plan on Floods implemented after 2020.


Modification of the theoretical return period of floods with high probability
State 1995
State 2005
State 2010
State 2020
State 2020+
Return period [a]
0
5
10
15
20
25
Maxau
Worms
Mainz
Kaub
Andernach
Sieg - Ruhr
Ruhr - Pannerdensche Kop
Waal
Nederrijn - Lek
IJssel


Modification of the theoretical return period of floods with medium probability
State 1995
State 2005
State 2010
State 2020
State 2020+
Return period [a]
0
50
100
150
200
250
300
350
Maxau
Worms
Mainz
Kaub
Andernach
Sieg - Ruhr
Ruhr - Pannerdensche Kop
Waal
Nederrijn - Lek
IJssel


Modification of the theoretical return period of floods with low probability
State 1995
State 2005
State 2010
State 2020
State 2020+
Return period [a]
0
500
1000
1500
2000
2500
3000
3500
4000
Maxau
Worms
Mainz
Kaub
Andernach
Sieg - Ruhr
Ruhr - Pannerdensche Kop
Waal
Nederrijn - Lek
IJssel

The graphics show:

The return periods determined, that is, their changes represent the increasing available retention volume according to the state of development. The following explanations can be taken as an example:

- Worms gauging station: For the section just upstream of the Worms gauging station, development stages for 2020 and in particular for 2020 plus show a distinct increase in the retention volume (the volume almost doubles between the state 2020 and 2020plus). Thus, for these development stages, changes due to the determined theoretical return periods are striking (for discharges of medium and low probability).

- Andernach gauging station: The modification of the theoretical return period due to the effect of retention measures distinctly decreases due to the confluence of the Moselle. Only floods which are distinct already on the Upper Rhine can be effectively reduced at the Andernach gauging station with retention measures on the Upper Rhine. The greater a share of a Moselle flood is at Andernach, the smaller the influence is of measures taken on the Upper Rhine.

- Downstream of the mouth of R. Sieg: For all flood classes (high, medium and low probability) the greatest changes appear to occur between the states 2010 and 2020 and 2020 and 2020plus. The reason is above all the accomplishment of measures aimed at enlarging the cross-section of the river until 2020. The increase of return periods after 2020 largely concerns floods with medium and low return periods and will above all be due to retention measures planned along the Upper and the Lower Rhine.

- Dutch branches of the Rhine: The theoretical return periods determined above all show the great difference between the characters of the three Rhine arms. On the one hand, the hydraulic capacity is concerned (about 2/3 of the water at Lobith is discharged through R. Waal, 2/9th through Nederrijn/Lek and 1/9th through R. IJssel). On the other hand due to the effectiveness of the different measures (e.g. vast lowering of groynes in R. Waal and flood channels and relocations of dikes along R. IJssel).

The table on the next page summarizes all results.

Section	Probabilities	Discharges [m³/s]	Theoretical return periods [a] related to the procedure accomplished with the HVAL investigation sample for the development stages				
			1995	2005	2010	2020	2020plus
Evaluation per gauge							
Maxau gauging station (Upper Rhine / Iffezheim - mouth R. Neckar)							
Flood return periods related to the HVAL investigation sample	High probability	*4,100 m³/s*	14 a	17 a	17 a	19 a	21 a
	Medium probability	*5,000 m³/s*	145 a	182 a	182 a	209 a	282 a
	Low probability	*6,500 m³/s*	1698 a	1778 a	1778 a	1778 a	1950 a
Worms gauging station (Upper Rhine / mouth R. Neckar - mouth R. Main)							
Flood return periods related to the HVAL investigation sample	High probability	*4,750 m³/s*	12 a	12 a	12 a	14 a	14 a
	Medium probability	*6,000 m³/s*	123 a	162 a	166 a	245 a	324 a
	Low probability	*7,600 m³/s*	1585 a	1862 a	1862 a	2344 a	3631 a
Mainz gauging station (Upper Rhine / mouth R. Main - mouth R. Nahe)							
Flood return periods related to the HVAL investigation sample	High probability	*5,700 m³/s*	11 a	11 a	11 a	13 a	13 a
	Medium probability	*7,900 m³/s*	129 a	151 a	155 a	182 a	240 a
	Low probability	*10,300 m³/s*	1622 a	1622 a	1622 a	1778 a	1995 a
Kaub gauging station (Middle Rhine / mouth R. Nahe-mouth R. Moselle)							
Flood return periods related to the HVAL investigation sample	High probability	*5,800 m³/s*	11 a	11 a	12 a	13 a	13 a
	Medium probability	*8,000 m³/s*	129 a	148 a	155 a	178 a	234 a
	Low probability	*10,400 m³/s*	1622 a	1660 a	1660 a	1820 a	1905 a
Andernach gauging station (Middle Rhine / mouth R. Moselle-mouth R. Sieg)							
Flood return periods related to the HVAL investigation sample	High probability	*8,810 m³/s*	11 a	11 a	11 a	12 a	12 a
	Medium probability	*11,850 m³/s*	100 a	107 a	110 a	120 a	138 a
	Low probability	*15,250 m³/s*	1023 a	1096 a	1122 a	1175 a	1259 a
Evaluation per section							
Mouth R. Sieg - mouth R. Ruhr							
Flood return periods related to the HVAL investigation sample	High probability	*8,900 m³/s*	11 a	11 a	11 a	11 a	12 a
	Medium probability	*11,700 m³/s*	94 a	93 a	96 a	106 a	120 a
	Low probability	*15,300 m³/s*	1140 a	1130 a	1170 a	1358 a	1466 a
Mouth R. Ruhr - Pannerdensche Kop							
Flood return periods related to the HVAL investigation sample	High probability	*9,380 m³/s*	10 a	10 a	10 a	12 a	12 a
	Medium probability	*12,200 m³/s*	79 a	79 a	78 a	104 a	115 a
	Low probability	*15,800 m³/s*	763 a	751 a	743 a	1402 a	1706 a
Waal (until km 938)*							
Flood return periods related to the HVAL investigation sample	High probability	*9,500 m³/s*	10 a	11 a	11 a	13 a	13 a
	Medium probability	*12,700 m³/s*	99 a	105 a	110 a	152 a	169 a
	Low probability	*16,000 m³/s*	1050 a	1107 a	1161 a	1611 a	2178 a
Nederrijn-Lek*							
Flood return periods related to the HVAL investigation sample	High probability	*9,500 m³/s*	10 a	10 a	10 a	13 a	13 a
	Medium probability	*12,700 m³/s*	80 a	83 a	93 a	151 a	166 a
	Low probability	*16,000 m³/s*	881 a	912 a	975 a	1611 a	2070 a
IJssel*							
Flood return periods related to the HVAL investigation sample	High probability	*9,500 m³/s*	3 a	3 a	3 a	13 a	13 a
	Medium probability	*12,700 m³/s*	20 a	22 a	22 a	147 a	158 a
	Low probability	*16,000 m³/s*	344 a	364 a	392 a	1611 a	2080 a

**Discharge information for Lobith gauging station*

Summarizing table of the determined theoretical return periods concerning the procedure with the HVAL investigation sample (for analysis of the EG HIRI).