Internationally Coordinated Management Plan 2015 for the International River Basin District of the Rhine

(Part A = Overriding Part)
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of the Swiss Confederation

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Competent Authorities in the Rhine river basin district

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Introduction

The European Water Framework Directive (Directive 2000/60/EC, in the following WFD) has set new standards in water policy for EU Member States. Running waters, lakes, coastal and transitional waters within a river catchment (river basin district) are to be considered as an ecosystem, aspects of protection and use are to be harmonised as far as possible.

In general, the target of the WFD is to achieve the good status of all surface waters and of groundwater by 2015. To this end, inventories are to be conducted in all river basin districts (RBD) and monitoring programmes as well as coordinated management plans are to be drafted. The participation of the public in the process of implementation is an essential element of the WFD. In this connection, the international river basin commissions, such as the International Commission for the Protection of the Rhine (ICPR) act as transboundary coordination platforms.

Since the ICPR does not cover the entire river basin district, the Coordination Committee was founded in 2001, which also integrates Liechtenstein, Austria and the Belgian region Wallonia into the coordinated implementation of the WFD. Switzerland is not bound by the WFD but does support the EU Member States in their coordination and harmonisation work within the framework of conventions under international law and national Swiss law.
Today, the ICPR and the Coordination Committee work in a joint working structure. In 2004, the Coordination Committee presented a report on the delimitation of the Rhine river basin district, the network of waters part A and the competent authorities[1], followed by a first report on the first joint inventory[2] in 2005, a report on the coordination of surveillance monitoring programmes[3] in 2007, and the first internationally coordinated Management Plan[4] for the international river basin district (IRBD) Rhine in 2009.

So far, the coordination results concerning the implementation of the WFD in the Rhine catchment are composed of the overriding parts for the entire river basin district (part A) and of national or transboundary parts B. The B-parts either consist of coordination reports in some of the nine sub-basins or of national reports coordinated at a transboundary level. These nine sub-basins have been delimited on the basis of natural features and are mostly international: Alpine Rhine/Lake Constance, High Rhine, Upper Rhine, Neckar, Main, Middle Rhine, Moselle/Sarre, Lower Rhine, Delta Rhine. In the sub-basins Alpine Rhine/Lake Constance and Moselle/Sarre the working structures of the already existing commissions (international water protection commissions for Lake Constance, International Commissions for the Protection of Moselle and Sarre) are being used; these sub-basins continue to establish their own reports.

The WFD provides for a management plan every 6 years. The first Management Plan of 2009 is to be evaluated by the end of 2015 and updated wherever required. That is also true of some of the steps required for drafting the second Management Plan in 2015, e.g. the inventory according to Article 5 WFD. The ICPR has updated the inventory but has not drafted any new report. The WFD only requires a report for the first inventory. Updates are integrated into the Management Plan 2015 (part A) at hand.

Information from the Management Plan 2009 is only repeated to the necessary extent, in all other cases it is being referred to texts easily accessible on the ICPR website.

As in 2009, the overriding part of the Management Plan 2015 for the IRBD Rhine (Part A) is drafted jointly by the representatives of all states concerned within the ICPR and the Coordination Committee in charge of implementing the WFD. With respect to surface water bodies, the document again focusses on the main stream of the Rhine and major

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[1] Competent authorities
[2] First inventory
[3] Monitoring programmes
[4] 1. Management plan

tributaries, such as Neckar, Main, and Moselle with catchment areas above 2,500 km² (see K2). For the other surface waters reference is made to national or transboundary management plans (parts B) with links in Chapter 8 and to the ICPR website.

Statements on groundwater concern all groundwater bodies in the IRBD Rhine.

The Management Plan 2015 (part A) describes the monitoring results of the Chemistry and Biology Monitoring Programmes for the Rhine, the targets to achieve and the programmes of measure. The Management Plan, therefore, on the one hand, serves as a means of information for the public and the European Commission while, on the other, it records international coordination and cooperation between the states in the river basin district as required by Article 3, Paragraph 4 and Article 13, Paragraph 3 WFD.

With respect to the four essential management issues for the international river basin district (IRBD) Rhine, nothing has changed since 2009. They represent permanent tasks for the states in the Rhine catchment.

- **"Restoration"[5] of biological river continuity, increased habitat diversity;**
- **Reduction of diffuse inputs interfering with surface waters and groundwater (nutrients, pesticides, metals, dangerous substances from historical contamination and others)**
- **Further reduction of classical pollution of industrial and municipal point sources**
- **Harmonisation of water uses (navigation, energy production, flood protection, regional land use and others) with environmental objectives.**

When treating the four major management issues, effects of climate change and changes in the discharge regime of the Rhine, among others more frequent flood events, longer lasting phases of low water, and rising water temperatures must be taken into account.

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[5] As far as possible, river continuity is to be restored.

1. General description

The Rhine connects the Alps with the North Sea. It is 1,233 km long and is one of the most important rivers in Europe. The river catchment area covering some 200,000 km² spreads over nine states (see Table 1). The Rhine has its source 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 and, together with the River Maas, it forms a wide river delta. The Wadden Sea adjacent to Lake IJssel fulfils an important function in the coastal ecosystem.

Table 1: 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 (Constance), 1,253 m^3/s (Karlsruhe-Maxau), 2,290 m^3/s (Rees)
Important tributaries	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
Major functional use	Navigation, hydropower, industry (abstraction and discharge), municipal water management (wastewater treatment and rainwater), agriculture, drinking water supply, flood protection, leisure and nature

Further information on the boundaries of the IRBD, major tributaries and other features are found in the maps K 1 (topography and soil cover according to Corine Land Cover), K 2 (areas of operation with a water network > 2,500 km²) and K 3 (Location and limits of water bodies)[6].

Half of the surface of the Rhine catchment area is used for agricultural purposes; about one third is forest area; almost 10 % are built-up areas and some 2.5 % are covered by water (see Table 2). Lake Constance, Lake IJssel, smaller stagnant waters, the Rhine and its tributaries (but neither the Wadden Sea, nor the coastal waters) belong to these water bodies.

The Rhine is one of the most intensively used watercourses of the earth. In the past and with a view to reducing the associated pollution, extensive measures entailing high costs were implemented. Further efforts are still required.

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[6] For the Netherlands, the Prinses-Margriet-Canal has been included in the maps, but it is only classified at Level B.

Table 2: Major characteristic data of the IRBD Rhine (states) - rounded. Land use data according to Corine Land Cover 2006

		IRBD Rhine	IT	CH	LI	AT	DE	FR	LU	BE	NL
Surface	km²	197,270	100	27,930	200	2,370	105,420	23,830	2,520	800	34,100*
Share in the total surface of the international river basin district Rhine	%		0.1	14.2	0.1	1.2	53.4	12.1	1.3	0.4	17.3
Inhabitants		59,907,000	0	6,342,000	36,000	370,000	36,568,000	3,851,000	497,000	43,000	12,200,000
Share in the total number of inhabitants in the international river basin district Rhine	%		0.0	10.6	0.1	0.6	61.0	6.4	0.8	0.1	20.4
Built-up area and settlement	km²	17,340	<10	950	20	170	10,840	1,840	220	40	3,260
Open space	km²	4,300	<10	3.290	10	250	350	100	<10	<10	290
Farmland	km²	45,120	<10	4,500	20	30	29,610	6,900	310	40	3,700
Permanent crop	km²	2,570	<10	30	<10	<10	2,070	390	20	<10	50
Greenland	km²	49,350	<10	5,060	40	910	23,260	5,510	1,050	400	13,120
Wood/forest	km²	65,260	<10	12,930	70	930	38,860	9,230	920	290	2,020
Wetlands	km²	550	<10	20	<10	30	90	20	<10	<10	380
Water surfaces	km²	4,880	<10	1,040	<10	40	930	210	10	<10	2,650**

Legend

IT	Italy
CH	Switzerland
LI	Liechtenstein
AT	Austria
DE	Germany
FR	France
LU	Luxembourg
BE	Belgium
NL	Netherlands

* Including Wadden Sea and coastal waters until the 12 miles zone (8,710 km²)

** Without Wadden Sea and coastal waters until the 12 miles zone

In order to improve water quality, so far 96 % of the about 60 million people living in the Rhine river basin district have been connected to a wastewater treatment plant. Many big industrial plants or chemical parks (a considerable part of the worldwide chemical production is located in the Rhine catchment area) have their own wastewater treatment plants which are, at least, state-of-the-art facilities. As a result of considerable investments into the construction of wastewater treatment plants in all states, point sources now contribute less often to classical pollutant contamination than in the past. The pollutant and nutrient contamination currently being observed is largely of diffuse origin. Agriculture and municipalities have already made efforts to reduce these discharges.

The marked mining activities in the Rhine catchment area, particularly in the Moselle-Saar area, in the Ruhr area (until 2018) and the open-cast lignite mining areas along the left bank of the German Lower Rhine are equally relevant. Even though mining activities have decreased considerably and will continue to do so, their effects still endure in many places.

The climate is changing in Europe. Winters are expected to become more humid, while summers will presumably be drier. Regionally, the amount of precipitation falling in a short time may be greater than today. Among other things, for the Rhine this means that runoff levels and water temperature may change[7]. Climate change may impact flood protection, drinking water production, industrial activities, agriculture and nature. In the long term it is expected that the increase in temperature will lead to rising sea levels. In the Netherlands this among others leads to the penetration of salt from sea water into the inland which threatens the freshwater supply for different uses such as drinking water, nature, agriculture and industry. This threat will increase during low flow of the Rhine occurring more often and for longer periods of time, and may also be caused by climate change. The ICPR has drafted a first Strategy for Adapting to Climate Change[8]*.*

Due to requirements concerning the quality of the marine environment, in particular that of coastal waters into which the Rhine flows, Rhine water quality is of particular importance.

Furthermore, the Rhine delivers drinking water for some 30 million people. For drinking water purposes, several large water treatment plants abstract raw water directly (Lake Constance) or via riverbank filtration, or they abstract Rhine water filtered through the dunes.

The Rhine and a number of its tributaries contain sediments, some of which are considerably contaminated by industrial and mining activities in the past. As a result, during major flooding or dredging activities, for navigation purposes for instance, re-mobilised sediments may cause temporary pollution. The ICPR Sediment Management Plan adopted in 2009 treats this issue more in detail[9].

Hydromorphological modifications for navigation purposes and the use of hydropower, flood protection, soil improvement for agricultural purposes (melioration) and land reclamations have resulted in a distinct decrease of the natural habitat of the Rhine, so that many ecological functions of this lifeline have been restricted. However, important approaches towards developing water ecology in the water system are already in place such as the “Salmon 2020” programme, the Lake Constance Lake Trout programme, the Eel Management Plans, the “Habitat Patch Connectivity along the Rhine” and other such programmes concerning the alluvial areas or migratory fish in the Rhine catchment area, and in particular the Master Plan Migratory Fish Rhine adopted in 2009[10].

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[7] ICPR report no. 188; ICPR report no. 213; ICPR report no. 214

[8] ICPR report no. 219

[9] ICPR report no. 175

[10] Master Plan Migratory Fish Rhine

For further details and information on the IRBD Rhine please consult the first inventory of 2005[11].

According to the WFD, water bodies represent the smallest unit for management planning. They either correspond to uniform and major sections of surface waters, e.g. a part of a river or delimited groundwater bodies (WFD, Article 2, no. 10 and 12). For water bodies, among others status and environmental objectives are to be described.

The criteria to apply to the delimitation of water bodies are determined in WFD Annex II. In the first inventory of 2005, Chapter 2.1.1 describes the approach in detail for surface water bodies, while Chapter 2.2.1 gives a detailed description for groundwater bodies.

1.1 Surface water bodies in the IRBD Rhine

Map K 3 presents the location and boundaries of the water bodies (surface waters) in the network of water bodies relevant for the overriding part A (basic network of water bodies). Apart from the main stream of the Rhine it also includes the tributaries with catchments larger than 2,500 km², lakes with a surface area of more than 100 km² and, as artificial waters, the most important navigation lanes (canals).

The establishment of a water body typology reflecting the different “settlement patterns” and natural conditions of waters is an important basis for the evaluation of the status of waters mainly depending on biological elements. Furthermore, the distinction between types of water bodies is an essential prerequisite for delimiting water bodies as partial element of an IRBD.

The Rhine catchment area spreads over five of the System A ecological regions listed in Annex XI WFD:

- Eco-region 4 (Alps, altitude > 800 m),
- Eco-regions 8 and 9 (western and central high hills, altitude 200 – 800 m) and
- Eco-regions 13 and 14 (western and central lowlands, altitude < 200 m).

All states in the IRBD Rhine have chosen System B according to WFD (see Annex II, No. 1.1 WFD) to describe the types of surface water bodies.

The typology of the main stream of the Rhine is extensively presented in a separate report which also includes the profiles of the different types of river sections[12].

The types of water bodies in the IRBD Rhine are presented in Map K 4 (surface water bodies: types of water bodies). A harmonised representation of the national types of water bodies applicable to the IRBD Rhine is found in Chapter 2.1.1 of the inventory of 2005 and in the subsequent national updates (see parts B).

The type-specific reference conditions developed at a national level for the different types of water bodies serve as reference conditions. Please refer to the national management plans.

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[11] Inventory

[12] ICPR report no. 147

1.2 Groundwater

Map K 5 (groundwater bodies) represents the location and delimitations of groundwater bodies in the IRBD Rhine including the coordinated groundwater bodies (hatched) along the state frontiers.

Regarding the delimitation of groundwater bodies, please refer to Chapter 2.2.1 of the survey of 2005 and to intermediate national adaptations.

2. Human activities and stresses

2.1 Hydromorphological alterations

Numerous hydraulic engineering measures have resulted in vast hydromorphological alterations which have greatly impacted the ecological function of the Rhine. These effects include, among others, the almost complete restriction of river dynamics, the loss of alluvial areas, the decline of biological diversity, and disruption of fish migration.

Morphological alterations

Rectification and river bank stabilisations have shortened the course of the river and, along longer sections, the construction of dikes has cut off the floodplains from river dynamics. As a result, the natural structural variety and important structural elements which are required for natural species diversity and intact biocoenosis are lacking today.

Runoff regime

Eight hundred km of the Rhine between Rotterdam and Basel are navigable. From Iffezheim (Upper Rhine) to the North Sea estuary, the Rhine flows freely through the Waal, a branch of the Rhine without any obstacles. Other connections between the delta system of the Rhine and the North Sea such as the closure embankment of Lake IJssel and the sluices of the Haringvliet are not or only occasionally passable.

For navigation purposes (among others the depth of the navigation channel), hydropower generation and flood protection purposes, the water level of the main stream of the Rhine has been regulated and numerous hydraulic structures, such as locks, impoundments and dikes were built. Between the outlet of Lake Constance and Iffezheim, there are 21 impoundments serving hydropower generation in the main stream or in bypass rivers. For fish, biota and sediments, several of these impoundments are not passable or only to a limited extent. In the upper reaches of the Rhine (Alps and their foothills) there are numerous reservoirs and impoundments serving power generation; during power consumption peaks, the hydropower plants often regulate the water supply according to the need for power supply (“hydropeaking operation”). That means that flora and fauna are not only impacted by interference with river continuity but also by the surge effects of hydropeaking operation.

There are more than 100 barrages (often combined with hydropower plants and shipping) with barrage locks in the Neckar, Main, Lahn and Moselle tributaries. Additionally, there are several important navigation channels in the Rhine river basin district connecting several river districts, e.g. the Main-Danube-Canal. The ecological potential of these artificial waters is also to be used. At the same time, attention is drawn to the possible immigration of alien species.

According to the WFD, a water body may be classified as natural, heavily modified or artificial. The approach has been thoroughly described in Chapter 4 of the inventory of 2004. This differentiation is important for the environmental objectives a water body has to achieve. The classification was verified when drafting the Management Plan 2015.

For the overriding Rhine catchment > 2,500 km², the result of this classification is presented in map K 6 (Categories of waters- natural, artificial and heavily modified surface water bodies).

Effects

These hydromorphological alterations considerably impact the ecological function of the Rhine:

- The far reaching alteration of the solid matter transport partly leads to a total loss of river dynamics and of the biological diversity of running waters;
- Embankments along vast sections of the river, removal of floodplains and a distinct shortening of the course of the river are further factors of biological impoverishment and increase flow velocity;
- The many existing barrages considerably restrict the ecological continuity of the Rhine system:
  - Only few of them are passable for upstream migration, as upstream migration fish passages are either missing or, if present, not functioning sufficiently;
  - During downstream migration they may hardly be passed without any damage, as there are no downstream migration passages;
- The (serially operated) turbines in hydropower plants may lead to high cumulative mortality rates among downstream migrating fish populations;
- Each damming slows down the flow velocity around the barrages, enhances eutrophication and considerably changes species composition as well as the size of species populations;
- Downstream of the barrages flow velocity increases, the species composition and the size of species populations changes (e.g. favouring alien species);
- Depending on the intensity, hydro-peaking particularly aimed at power production according to the demand (peak power production) has more or less harmful consequences.

The maps K 7 (Large transverse structures: Upstream migration) and K 8 (Large transverse structures: downstream migration) give an overview over the passability of the large transverse structures in the water network of the international river basin district Rhine with its sub-basins > 2,500 km². The additional programme waters for migratory fish with smaller sub-basins, as e.g. shown in the maps accompanying the "Master Plan Migratory Fish Rhine"[13] are not included here. Due to the short distances between the transverse structures on the Upper Rhine between Basel and Strasbourg, the representation of the river section concerned is magnified in the map on downstream fish migration.

Map K 7 presents the passability of transverse structures for upstream migrating fish such as salmon or, in the Alpine Rhine, for the Lake Constance lake trout, map K 8 presents downstream passability of transverse structures for downstream migrating fish, e.g. eel. Based on their knowledge / existing expert reports, national fish experts have assessed the passability of the constructions for fish. The assessment of passability of transverse structures in transboundary waters has been coordinated bilaterally.
For reasons of clarity in the scale of the river district, the representation has here been limited to transverse structures with a height of fall ≥ 2 m. But for most upstream moving fish species, transverse structures with a lower height of fall may also present a migration obstacle. Hydropower plants at such transverse structures without any fish protection equipment may bring about severe to lethal injuries for downstream migrating eel, salmon smolt etc.

Transverse structures without hydropower generation do not lead to mortality induced by turbines (see map K 8), but fish may be injured at the weir overflow of individual transverse

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[13] ICPR report no. 179; ICPR report no. 206

structures. Also, due to a longer stay at migration obstacles and disorientation after the weir overflow, the risk of predation rises.

For transverse structures with hydropower generation it must be taken into account that one or more turbines at a site causing great damage lead to a mortality rate evaluated as low (< 10 %), if only a small share of the discharge is used during phases of downstream migration. At successive hydropower plants mortality/injuries will cumulate, even if downstream migration passages exist and/or if mortality rates at every single site are evaluated to be low. For a species like salmon this cumulative effect may be limiting, if all juvenile salmon of a sub-basin must pass by several hydropower plants. Therefore, the best state of the art should be applied to effectively lower the cumulative fish mortality and, if possible, to rule out an endangerment of the population.

Water intakes

Surface water bodies

Water intakes for purposes of process water, domestic use or energy production may interfere with water bodies.

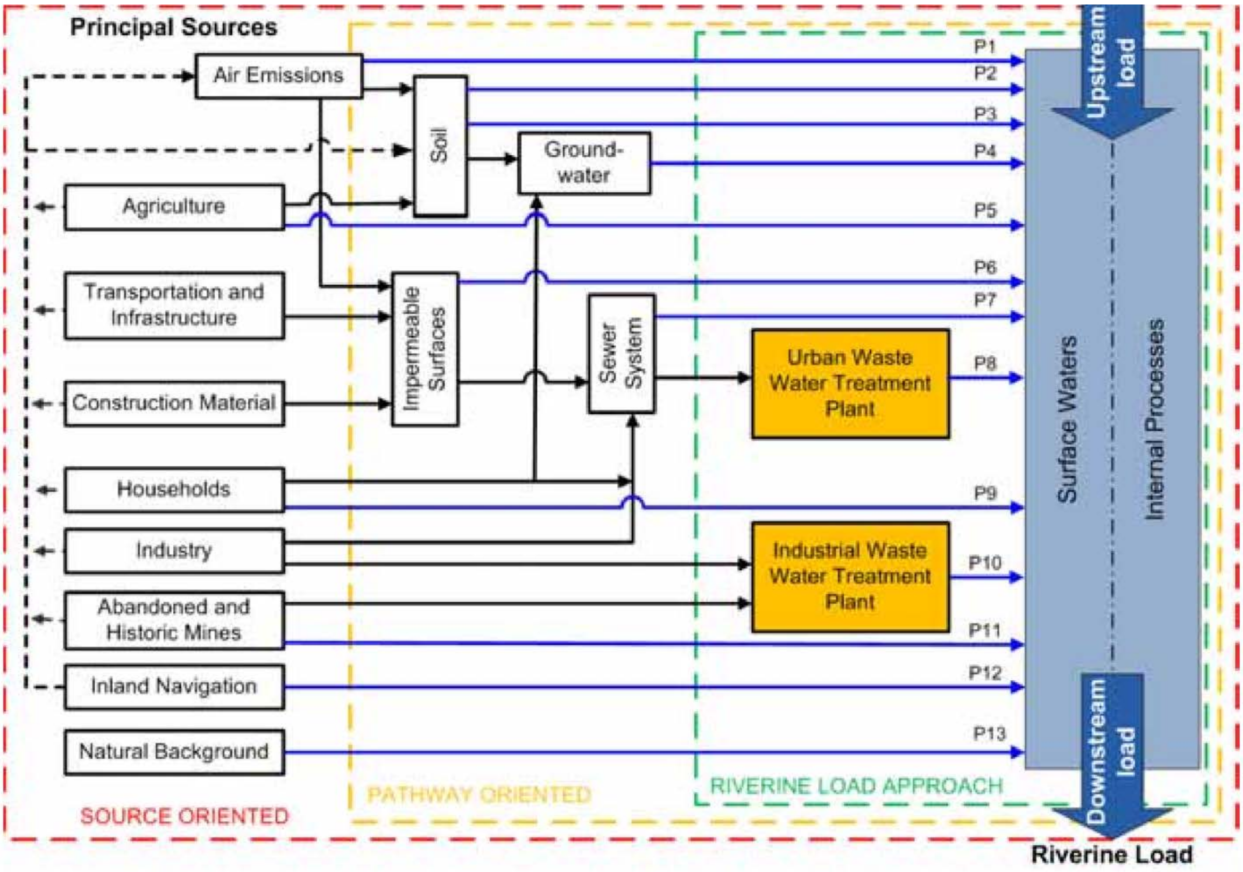
Apart from Luxembourg, there are no significant water intakes from surface water bodies in the basic network of water bodies of the IRBD Rhine. Greater intakes for drinking water supply are located along Lake Constance and in the Rhine delta.

Groundwater intakes

Abstraction of groundwater for public drinking water supply is an important factor in large areas of the Rhine catchment area. Additionally, groundwater is used in mining, industry, trade and for irrigation purposes in agriculture. In spite of numerous quantitative stresses, the quantitative state of groundwater in the Rhine catchment is basically not considered as being at risk. Stresses on the quantitative state of groundwater due to the lowering of the groundwater level in open-cast lignite mining along the Lower Rhine and in the mining area in Saarland are exceptions. Along the German Lower Rhine and in the Rhine delta, land ecosystems depending on groundwater are locally impacted, e.g. drying up due to water intake and for which locally effective measures must be taken.

2.2 Chemical pollution from diffuse and point sources

Chemical substances play an important role when assessing the status of surface and groundwater bodies. Chemical contamination can be attributed to diverse diffuse and point sources as presented in Figure 1[14].



Emission path no.	Input pathway
P1	Atmospheric Deposition directly to Surface Waters
P2	Erosion
P3	Surface runoff from unsealed areas
P4	Interflow, Tile Drainage and Groundwater
P5	Direct Discharges and Drifting
P6	Surface runoff from Sealed Areas
P7	Storm Water Outlets, Combined Sewer Overflows and Unconnected Sewers
P8	Urban Waste Water Treated
P9	Individual – Treated and Untreated – Household Discharges
P10	Industrial Waste Water Treated
P11	Direct Discharges from Mining Areas
P12	Direct Discharges from Navigation
P13	Natural Background

Figure 1: Emission pathways for determining the contamination of surface waters (see CIS Guidance Document no. 28)

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[14] see Common Implementation Strategy for the Water Framework Directive (2000/60/EC), 2012, Technical Guidance on the Preparation of an Inventory of Emissions, Discharges and Losses of Priority and Priority Hazardous Substances, Guidance Document No. 28

2.2.1 General remarks

Point sources

In the international river basin district Rhine, the wastewater from households and plants connected to the public sewage system, the so-called indirect discharges are treated in approx. 5,000 wastewater treatment plants. This means that the majority of the population (96 %, see chapter 6.1) is connected to a wastewater treatment plant. This number is higher than what was indicated in the Management Plan 2009. The inventory at that time was incomplete with respect to smaller wastewater treatment plants.

Between 2000 and 2010, the total volume of urban wastewater treatment plants in the Rhine catchment amounting to about 100 million population equivalents (p.e.) remained almost unchanged.

178 wastewater treatment plants have a volume > 100.000 (p.e.). In numbers, this category of wastewater treatment plants represents less than 4 % of the just under 5,000 wastewater treatment plants in the Rhine catchment. The treatment capacity of these plants represents 50 % of the total capacity in the Rhine catchment.

More than 3,400 wastewater treatment plants, that is more than 2/3 of all wastewater treatment plants in the Rhine catchment dispose of a comparatively small capacity < 10,000 p.e.. The total capacity amounts to 8.4 million p.e. (8 %).

Figure 2 and Table 3 show a further differentiation between the different sizes of wastewater treatment plants.

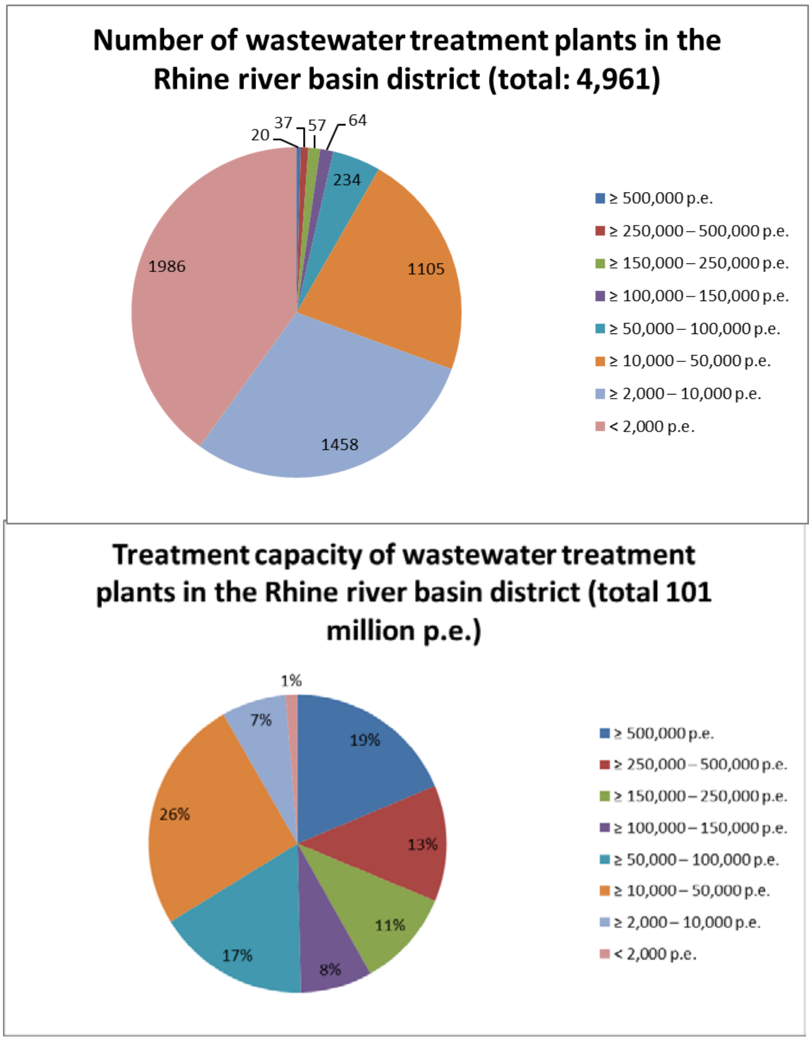

Figure 2: Number of wastewater treatment plants and percentage of the total treatment capacity per category of wastewater treatment plant in the Rhine catchment, state 2010.

Table 3: Number of wastewater treatment plants and total treatment capacity per category of wastewater treatment plants in the waters part A and part B of the Rhine catchment (state 2010)

Category of wastewater treatment plant (p.e.)	Number of wastewater treatment plants per category in waters part A	Number of wastewater treatment plants per category in waters part B	Treatment capacity per category (Million p.e.) in waters part A	Wastewater treatment plants per category (million p.e.) in waters part B
≥ 500,000	12	8	10.6	8.2
≥ 250,000 – 500,000	26	11	8.4	4.3
≥ 150,000 – 250,000	23	34	4.5	6.2
≥ 100,000 – 150,000	28	36	3.2	4.6
≥ 50,000 – 100,000	90	144	6.7	10.0
≥ 10,000 – 50,000	291	814	7.6	18.0
≥ 2,000 – 10,000	260	1198	1.3	5.7
<2,000	280	1706	0.2	1.1
Sum	1010	3951	42.5	58.1

Table 3 shows that wastewater treatment plants with a larger treatment capacity are evenly distributed across waters according to part A and part B. Most wastewater treatment plants with a smaller treatment capacity mainly discharge into the smaller part B water bodies.

In the EU, the discharge of urban wastewater into water bodies is regulated in the **Council Directive concerning the treatment of urban wastewater** (Directive 91/271/EEC). Depending on receiving waters and constraints, this directive imposes deadlines for the implementation of the 2nd and 3rd treatment stage and the date by which urban wastewater must respect certain discharge concentrations and decomposition performances. In this connection, the states have determined the obligations for sensitive areas according to this directive for the Rhine catchment. Today, this directive is comprehensively implemented in large parts of the Rhine catchment.

The load discharged by the wastewater treatment plants is of various origin. Households (among others consumer products) as well as indirect industrial discharges range among the sources. This also applies to corrosion from construction material, atmospheric deposition and traffic, a pollution which is discharged into wastewater treatment plants through combined sewer networks during rainfall.

The **Industrial Emissions Directive** 2010/75/EU, in short **IED** and its regulations concerning the operation, surveillance and shutdown of industrial plants in the European Union substituting the IPPC-Directive of 1999 applies to industrial discharges.

The continuous analysis of waters confirms that, during the past decades the purification of water bodies has been very successful. The pollutant load has been considerably reduced. Among others, this success is due to the consequent state of the art improvement of industrial and urban wastewater treatment.

Diffuse sources

Apart from point sources, diffuse sources represent considerable input pathways contributing to the pollution of water bodies and groundwater. Efficient reduction measures presuppose a consideration of input pathways (emission control).

The framework for a reduction of the pollution of waters resulting from agricultural uses is given by the following European regulations:

The **Nitrates Directive** (91/676/EEC) sets European standards for the reduction of nitrate discharges of agricultural origin. In the past years, the situation concerning nitrates has improved, but the nitrates pollution remains tangible.

In the meantime, the **Plant Protection Products Directive** (Directive 91/414/EEC) repealed by the EC Regulation no. 1107/2009 concerning the placing of plant protection products on the market, the Directive establishing a framework for Community action to achieve the sustainable use of pesticides (Directive 2009/128/EU) and national regulations and recommendations on the proper use of plant protection products, e.g. the targeted implementation of measures on a cooperative basis in water protection areas have contributed to achieve improvements with respect to the discharge of plant protection products. Furthermore, based on the Directive 2009/128/EC, national action plans targeted at reducing the risks arising from the application of plant protection products have been and continue to be implemented. However, measurable contaminations with plant protection products are still being recorded in the basic network of water bodies. In particular, during certain periods of the year, pollution originating from these products is regularly determined in smaller water bodies.

The Rhine figures among the most important shipping lanes of the world and is the most important shipping lane in Europe. With a view to limiting emissions from navigation, the Convention on the Collection, Deposit and Reception of Waste produced during navigation on the Rhine and inland waterways **(CDNI)** entered into force on 1st November 2009. This convention regulates the handling of oily and greasy ship waste (part A), cargo waste (part B) and other ship waste, such as wastewater and household waste of passenger and hotel ships (part C).

Since 2012 it is forbidden to discharge household wastewater from hotel and passenger ships with a capacity of more than 50 persons into surface water bodies. Ships may only discharge treated wastewater or must securely dispose of untreated wastewater at the pier. Since 2009 it is forbidden by Dutch law that toilet water from leisure boats with a capacity below 50 Persons is discharged into inland waters. To facilitate the implementation, 350 collection sites have since been implemented in the Netherlands.

2.2.2 Relevant discharges into surface water bodies

Nutrients

Excessive concentrations of nitrogen or phosphorus are problematic for the biological water quality of inland waters. Additionally, increased nitrogen loads have polluted the marine environment, in particular that of the Wadden Sea. This phenomenon is generally known as eutrophication. For the physico-chemical elements, national orientation values have been determined which are supposed to underpin the biological classification of the water quality.

Compared to national values, **phosphorus** concentrations show higher values at certain monitoring stations of the network of water bodies part A, as in many smaller waters in the catchment.

As far as eutrophication processes are concerned, **nitrogen** is not a limiting factor for inland waters on a local scale but it does play an important part at Level A, as it may be a source of coastal water pollution, in particular of the Wadden Sea.

The coastal water bodies off the Rhine estuary are highly sensitive and, considering their species diversity, particularly deserving of protection.

Efforts going on since 1985 to reduce nitrogen in all the states of the IRBD Rhine have already resulted in a reduction of nitrogen concentrations in the coastal waters. However, these concentrations are still above the Dutch guidance value of 0.46 mg DIN/l at a salinity of 30 (DIN = Dissolved Inorganic Nitrogen). Even though the total classification of the quality element phytoplankton along the Dutch coast is good to very good, the status in the Wadden Sea and its coast varies between moderate and good. In order to achieve a stable good status and to permanently respect the value of 2.8 mg TN/l (= total nitrogen) agreed upon in the ICPR, the reasons for pollution must be further observed and measures taken in all states of the IRBD Rhine must be continued unabatedly.

Substances relevant for the Rhine

According to a recent inventory (see Chapter 4), copper, zinc and PCB figuring among the 15 Rhine-relevant substances pose a problem at several monitoring stations, arsenic, chromium, ammonium-N at few monitoring stations and dichlorvos and dimethoate at one monitoring station each. Presently, the values for arsenic (water phase), 4-chloroaniline, bentazone, chlorotoluene, dichlorprop, MCPA, mecoprop and dibutyltin-cation are below the Rhine-EQS/guideline values.

Metals and PCB

There are several major sources for copper, the greatest one of which are storm water outlets, combined sewer overflows and unconnected sewers (P7). Regionally, the surface water runoff from sealed areas (P6) and precipitation water may be of great importance.

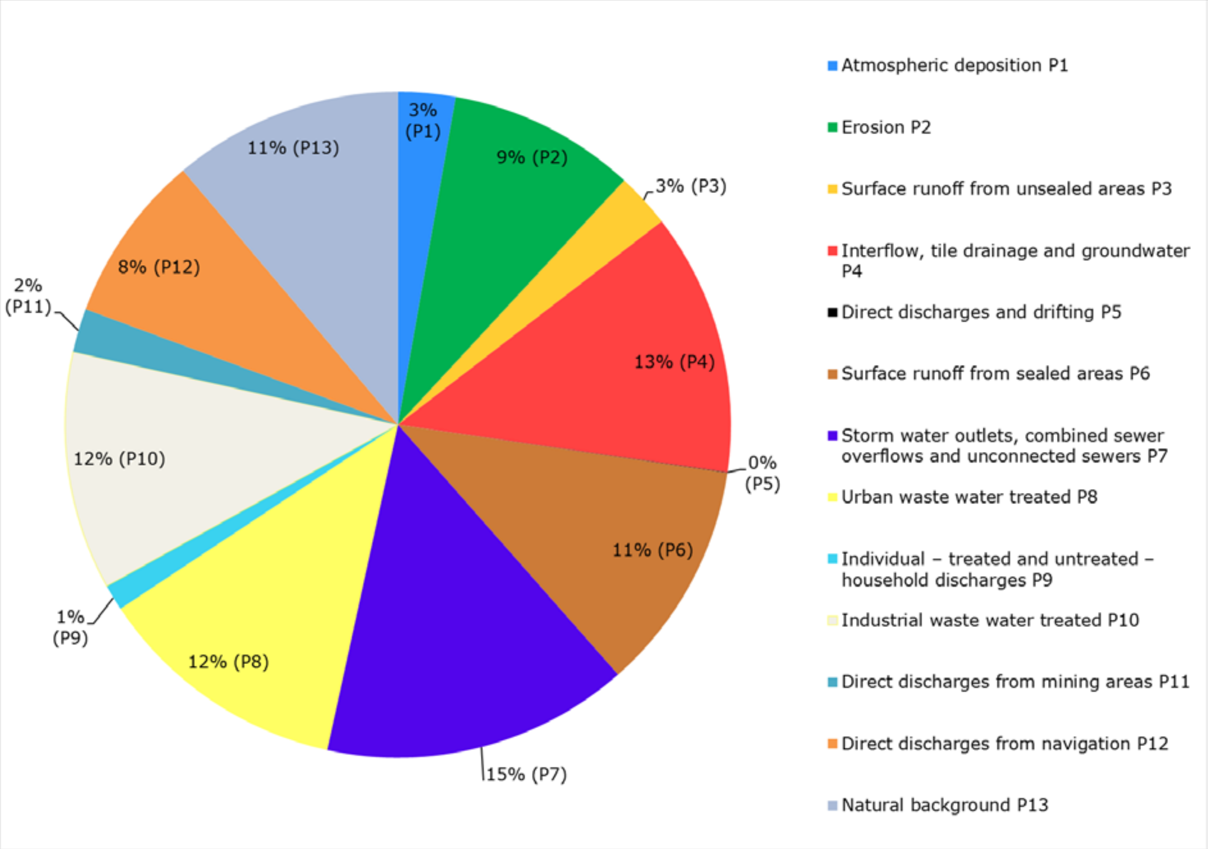

Figure 3: Distribution of copper discharges 2010 across the input pathways (total discharge 376 t)[15].

The main sources for zinc discharges are urban waste water treated (P8) and storm water outlets, combined sewer overflows and unconnected sewers (P7). Regionally, the runoff from sealed areas (P6) may be of great importance.

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[15] ICPR report “Inventory of Emissions for the Rhine catchment 2010” under preparation

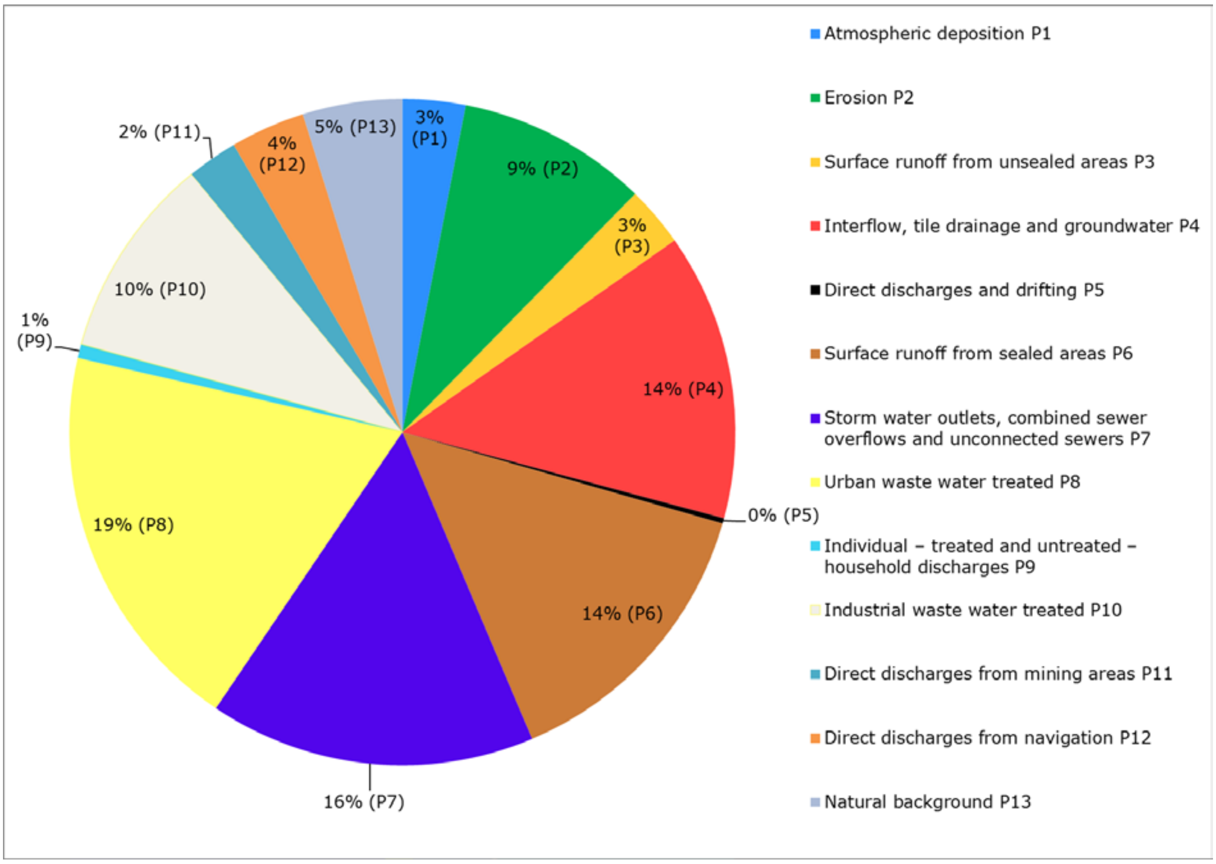

Figure 4: Distribution of zinc discharges 2010 across the input pathways (total discharge 1,448 t)[15].

Table 4: Survey of point source discharges[15] (rounded values)*

	1985	**1992**	**1996**	**2000**	**2010**	**2000**	**2010**	**2000**	**2010**
t / a	**Sum**	**Sum**	**Sum**	**Sum**	**Sum**	**Waste-water treat-ment plants**	**Waste-water treat-ment plants**	**Industry**	**Industry**
Total N	-	212,701	170,669	129,973	78,742	107,120	68,431	22,853	10,311
P	50,938	21,918	15,981	12,143	9,282	9,719	8,330**	2,424	952
Hg	2.8	1.53	0.94	0.66	0.18	0.35	0.10	0.31	0.08
Cd	21.76	4.08	1.8	1.67	0.78	0.86	0.46	0.81	0.32
Cr	651	106	63	46	19	11	9.37	35	9.49
Cu	469	150	114	105	90	57	46.15	48	43.53
Ni	394	102	62	63	69	32	38.54	31	30.89
Zn	2,199	811	650	465	419	358	276.85	107	142.57
Pb	303	90	65	43	11	24	6.14	19	4.81
As	-	21	17	11	5	2	3.24	9	1.77

* The data for the reference years 1985, 1992, 1996 and 2000 are taken from the ICPR report no. 134. Contrary to 2010, emissions from Austria, Liechtenstein, Luxemburg and Wallonia/Belgium as well as from the areas of the Wadden Sea, the Wadden islands and coastal waters have not been recorded. Minor differences compared to the results of nitrogen emissions in Table 12 (Chapter 7.1.2) are due to different methods of estimation.

** including urban diffuse (see Table 13)

As is shown in Table 4, apart from nickel, the emissions of priority and Rhine relevant metals from point sources were distinctly reduced during 2000-2010, even though the discharge area taken into account is larger than during the years up to 2000. Also, emissions of the problematic substances lead (Pb), cadmium (Cd) and mercury (Hg) have been distinctly reduced in wastewater treatment plants as well as in industrial emissions.

Formerly, PCBs were used as softening agents in plastic materials, in transformers and as a compound of hydraulic fluids, e.g. in mining. They are persistent and accumulate in the food chain as well as in sediments.

In individual cases, arsenic is detected above the EQS, among others in the tributaries of River Kinzig (Main) and River Erft. Presently, the source of arsenic pollution in River Kinzig (Main) is being investigated. It is assumed that the arsenic pollution of River Erft is caused by the former ore mines.

In the Wadden Sea, chromium is in excess of the EQS.

Due to the high share of sewage water, copper and zinc in River Schwarzbach (Main) are in excess of the EQS.

Ammonium-N

The pollution with ammonium-N at the monitoring station at the mouth of River Emscher is due to the particular water conditions of River Emscher draining an urban area. Reduction measures are planned.

The ammonium-N pollution at the monitoring station on River Vechte (NL) is above all caused by agricultural uses.

Plant protection agents

The plant protection agents dimethoate and dichlorvos are in excess of the environmental quality standards at one monitoring station each (Annex 2). The environmental quality standard Rhine for **dichlorvos** has been derived to 0.0006 µg/l which means that already low discharge quantities of agricultural origin may lead to values in excess of this standard.

The EQS Rhine for **dimethoate** has been derived to 0.07 µg/l. According to the Directive “Water intended for human consumption” (Directive 98(83/EC) (Annex 3) and some national regulations the standard has been fixed to 0.1 µg/l. The pollution stated in River Schwarzbach (Main) has its origin in the use of this substance in intensive fruit and vegetable growing in the Hessian Ried.

Priority substances and certain other pollutants of the Directive 2008/105/EC in the version of the Directive 2013/39/EU

In the IRBD Rhine, some of the 41 priority substances and certain other pollutants listed in the Directive 2008/105/EC in the version of the Directive 2013/39/EU are problematic[16] (see Chapter 4.1.2 and Annex 5):

- brominated diphenyl ethers (PBDE)
- hexachlorobenzene (HCB)
- hexachlorbutadiene
- nickel
- polycyclic aromatic hydrocarbons (PAH)
- mercury
- tributyltin

Even though, at the time being, the values for lead, cadmium and isoproturone are not in excess of the AA-EQS (annual average EQS), they are being considered with increased vigilance, as, in the past, values of these three substances were in excess of target values and EQS[16].

The Directive 2013/39/EU characterises **“persistent, bioaccumulative and toxic substances (PBTs) and other substances that behave like PBT”** as **“ubiquitous”** meaning that they continue to occur in almost all waters in Europe in unchanged high concentrations. The above mentioned substances/groups of substances of brominated diphenylether (PBDE), mercury, polycyclic aromatic hydrocarbons (PAH) and tributyltin (TBT) belong to them. Some PAH-compounds, that is anthracene, fluoranthene and naphthalene have not been classified as ubiquitous substances.

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[16] ICPR report no. 215

PFOS and dioxins, hexabromocyclododecane and heptachlorine also belong to the "ubiquitous substances" recently identified and regulated according to the Directive 2013/39/EU with the help of EQS and will have to be taken into account within additional surveillance programmes and programmes of measures as of December 22, 2018. PFOS was already listed in Annex III of the Directive 2008/105/EC.

Concerning the emission inventory[15], and contrary to the physico-chemical parameters and substances relevant for the Rhine, for which the area under consideration is limited to the 1-mile-zone, that considered for priority substances extends as far as the 12-mile-zone.

Development since 2009

The priority substances / groups of substances of the WFD in excess of the EQS and listed in the Management Plan 2009, cadmium, diuron, HCH and pentachlorobenzene are now below the AA-EQS.

Lead discharges are mainly due to erosion (P2) and storm water outlets, combined sewer overflows and unconnected sewers (P7).

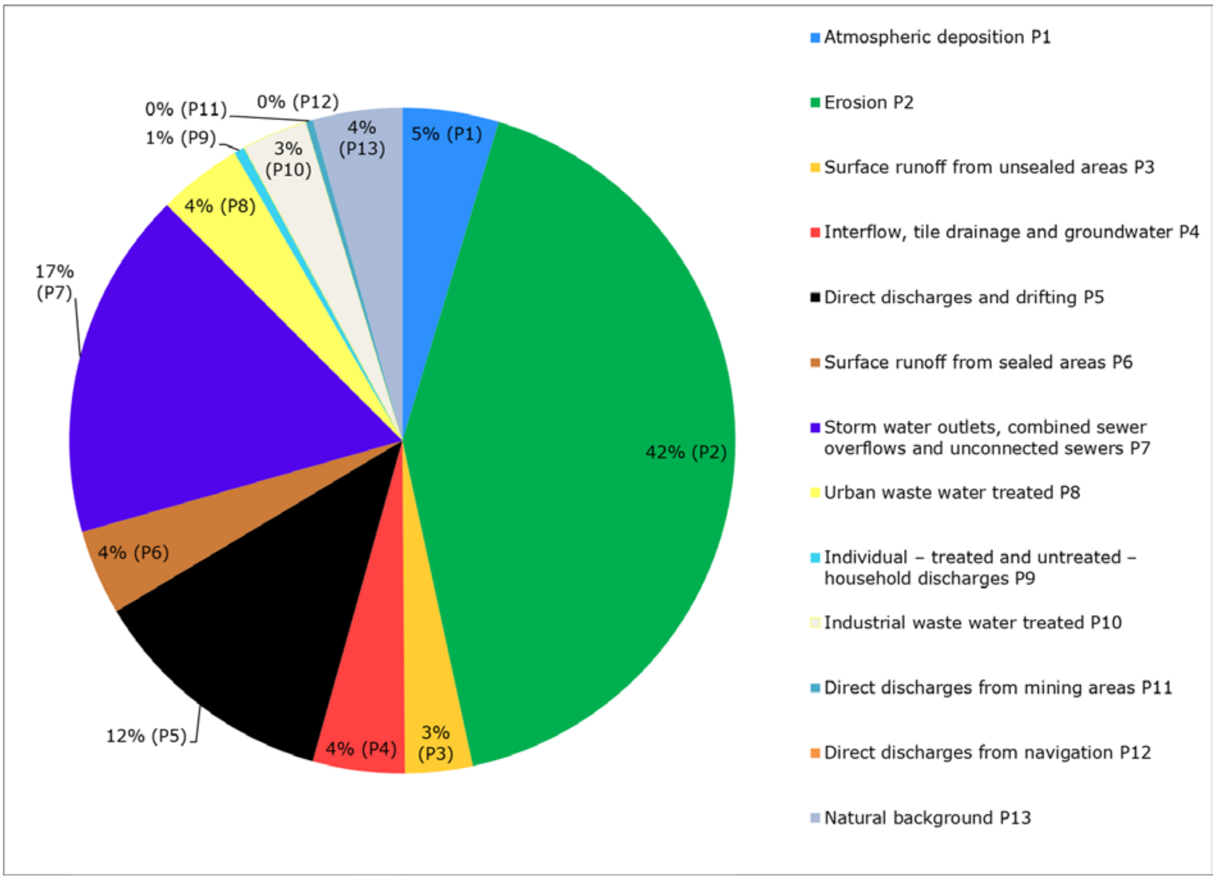

Figure 5: Distribution of lead discharges 2010 across the input pathways (total discharge 150 t)[15].

The main input pathway for **cadmium** is interflow, tile drainage and groundwater (P4). Apart from the natural background (P13), erosion (P2) and urban waste water treated (P8) are important discharge pathways.

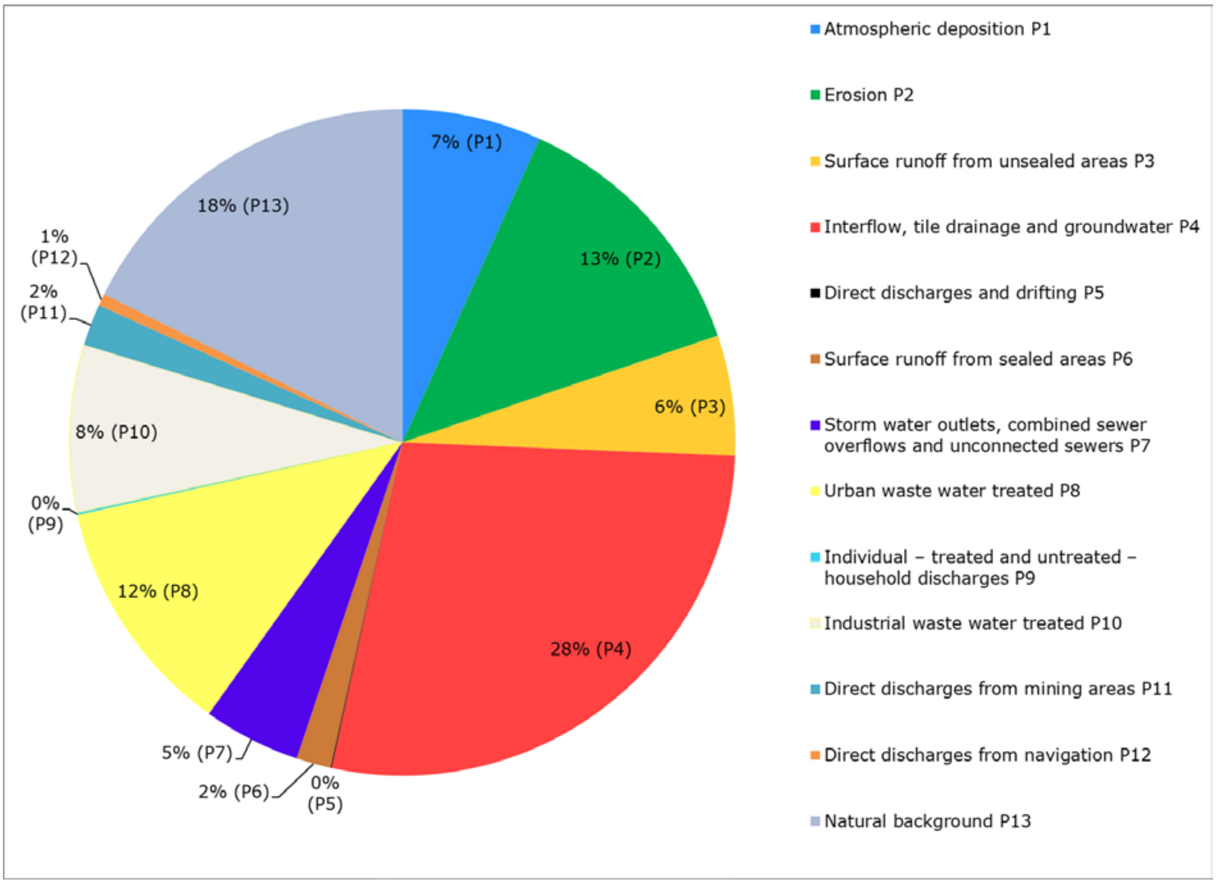

Figure 6: Distribution of cadmium discharges 2010 across the input pathways (total discharge 3,96 t)[15].

Nickel discharges originate from different sources, mainly interflow, tile drainage and groundwater (P4).

The main discharge pathways for **mercury** are atmospheric deposition (P1), as well as interflow, tile drainage and groundwater (P4).

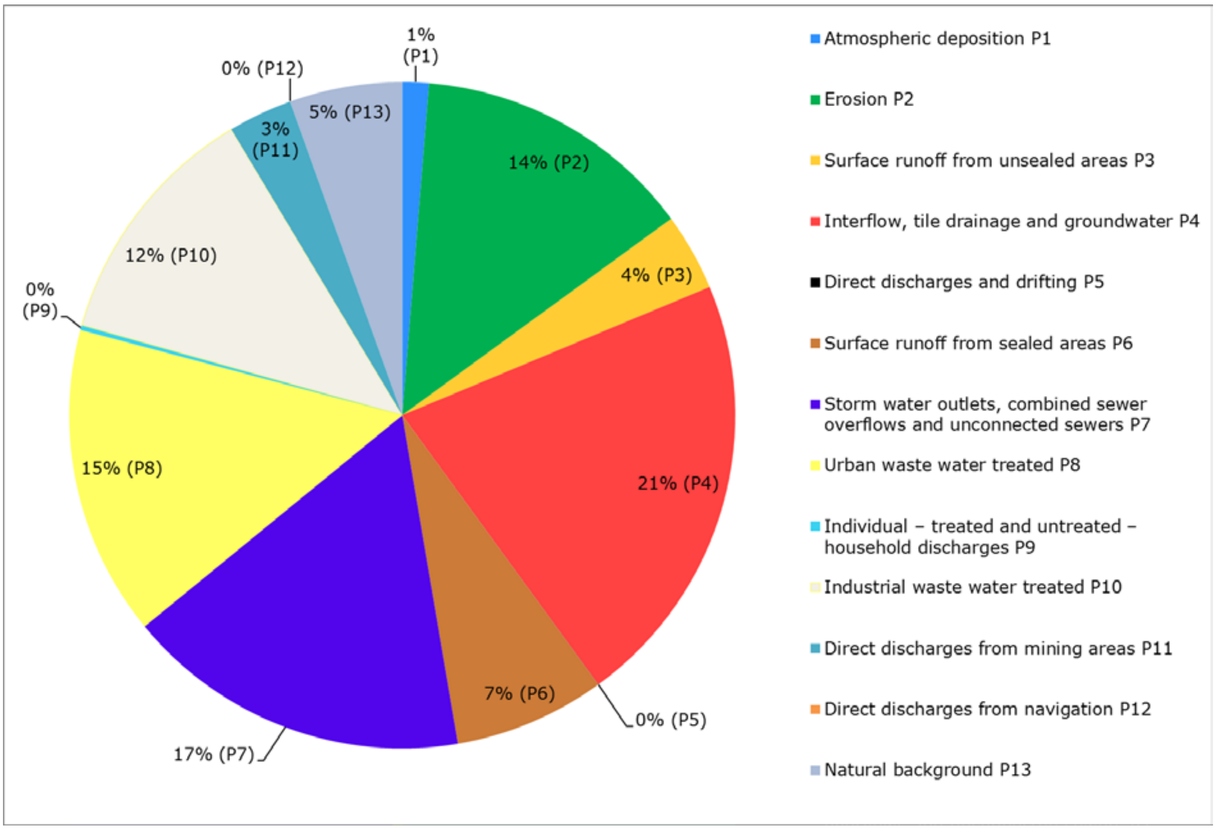

Figure 7: Distribution of nickel discharges 2010 across the input pathways (total discharge 256 t)[15].

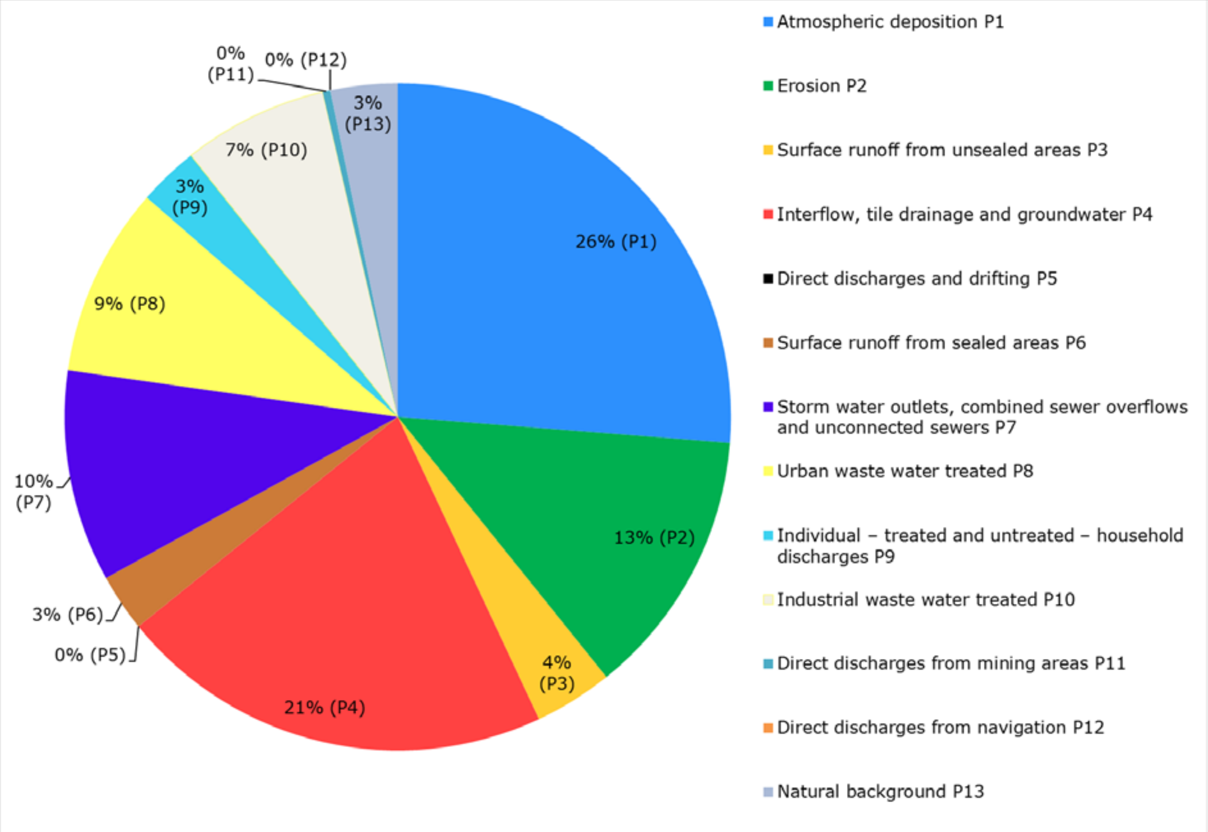

Figure 8: Distribution of mercury discharges 2010 across the input pathways (total discharge 1.08 t)[15].

So far, few data are available on **brominated diphenyl ethers (PBDE)**. Available data indicate PBDE values in excess of environmental quality standards at several monitoring stations of the surveillance monitoring network and in smaller water bodies.

HCB may be generated as by-product during the synthesis of chlorinated hydrocarbons and was formerly used as a softening agent and fungicide. The pollution today which is detected in the impounded Upper Rhine and in individual tributaries with values in fish in excess of the quality standards can first of all be attributed to historic inputs and continued accumulation in sediments.

Hexachlorobutadiene has not been classified as an ubiquitous substance. At two monitoring stations in North Rhine-Westphalia (Lippe, Emscher) this substance is in excess of the environmental quality standard. Further investigations aimed at determining input pathways and/or further developing effective treatment procedures are planned.

At times of winter cereal cultivation, distinctly detectable **isoproturon** pollutions of the Rhine occur, when application periods of the herbicide are followed by days with heavy rainfall. This also applies to the cultivation of summer cereals in springtime. The report on seasonal herbicide pollutions of the Rhine[17] was published in 2014.

The ubiquitous **PAH** are not directly bound to a local emission source. These substance inputs are above all caused by diffuse emissions from combustion plants and motors, car tyres, old ship coatings and the use of coal tar and creosote primarily applied as wood protection agents in hydraulic engineering. Atmospheric deposition is the main pathway of emissions. These statements partly also apply to fluoranthene, which has not been classified as ubiquitous.

The elevated **tributyltin** concentrations in River Lippe are partly caused by former applications in industry. Demonstrably, tributyltin is also discharged via wastewater treatment plants and, apart from industrial dischargers this also indicates a ubiquitous distribution of diffuse sources, e.g. caused by the use as a biocide. Among others, this leads to the pollution in River Emscher. In River Vechte, tributyltin has once (2012) been detected in concentrations above the standard, which was equally caused by diffuse sources. This substance is not detected in upstream sections of River Vechte.

Annex 4 gives a total overview over the substances und environmental quality standards (EQS) according to the Directive 2008/105/EC and the adapted EQS for some of the substances concerned by the Directive 2013/39/EU.

2.2.3 Relevant discharges into groundwater

The most important groundwater contamination is due in particular to **ammonium**, **nitrate** and **pesticides** and their metabolites, above all from diffuse agricultural sources. Furthermore, in urban areas, several substances of diffuse origin act as pollutants. Locally, point sources may be of importance. Taken as a whole, in a groundwater body, several point sources may impact groundwater quality.

2.3 Other impacts of human activities on the state of the waters

Further loads which may in particular play a part downstream of Lake Constance originate from different uses of the water bodies. Among them figure energy production, flood protection and navigation (lapping of waves, turbulences due to ships' propellers, spreading of invasive species or pollution due to accidents in navigation, illegal disposal of residual loads, cleaning or bulk water).

In addition, there are the consequences

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[17] ICPR report no. 211

- of historical uses in the Rhine catchment which have led to contaminated sediments and the risk of re-suspension and re-mobilisation due to floods or dredging (historical contamination);
- of mining (hydraulic, thermal and/or chemical pollution due to mine water or percolating water;
- of thermal pollution (cooling water discharge from power plants and industry).

The Rhine monitoring programme does not identify all pollutions or they are not recognizable as such under the evaluation of annual average values.

As an example, the areas of sediment pollution and thermal pollution may be highlighted.

Sediment pollution

The build-up of sediments is e.g. favoured by lower flow velocity caused by the construction of barrages. This also applies to harbours and the North Sea. Sediments may still be heavily polluted by formerly discharged substances. That means that floods or dredging bring about a risk of re-suspension or re-mobilisation.

In 2009, the ICPR adopted a Sediment Management Plan[18] which is currently being implemented[19]. In most of the 22 areas at risk designated by the Sediment Management Plan there are high PCB concentrations. Thirteen areas at risk are located in the Netherlands and are all polluted by high PCB contents. In the meantime, 10 sites have been cleaned up. The vastest cleaning up concerned the Ketelmeer-West. Numerous investigations during the last years suggest that for many years the HCB pollution has spread from the original discharge location near Rheinfelden (former production of PCP and chlorosilane) and across the chain of barrages in the Upper Rhine.

Thermal pollution

On average, between 1978 and 2011, Rhine water temperatures rose by about 1 °C to 1.5 °C. Generally, water temperatures rise due to climate change (see chapter 2.4).[20] Apart from that, thermal discharges (e.g. due to the use of surface water for cooling purposes, among others in power plants and industry) contribute to rising water temperatures. Ample thermal discharges permitted in 2010, i.e. those above 200 MW are listed in Table 5.

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[18] ICPR report no. 175 (2009)

[19] ICPR report no. 212 (2014)

[20] ICPR report no. 209 (2014)

Table 5: Survey "Permitted thermal discharges (> 200 MW) into the Rhine in 2010"

	Rhine-km	**Permitted thermal discharges (> 200 MW) 31/12/2010**
Fessenheim nuclear power plant	212.4	3600
Rhine Steam Power Plant Karlsruhe	359.5	1175
Philippsburg nuclear power plant	389.5	4265
Mannheim large power plant (June-Sept.)	416.5	1014 - 2027*
Mannheim large power plant (Oct.-May)	416.5	2027
BASF Ludwigshafen, cooling water**	428.0	1977
BASF Ludwigshafen, wastewater treatment plant**	433.0	280/380***
Biblis nuclear power plant	455.0	1674****
Mainz-Wiesbaden power plant	502.0	1035
GEW Köln AG, Cologne	694.0	394
Bayer AG, Leverkusen	700.0	611
Bayer AG/EC Dormagen	710.0	268
Lausward power plant, Düsseldorf	740.5	770
Bayer AG, Uerdingen power plant	766.0	461
SW Duisburg power plant	777.0	720
Herm. Wenzel power plant, Duisburg	781.0	545
STEAG Walsum	792.0	710
STEAG Voerde	799.0	820
Solvay, Rheinberg	808.0	208
Electrabel Nijmegen (Waal)	886.0	790
Electrabel Harculo (IJssel)	-	670

** Depending on the temperature of discharge*

*** Thermal discharges and cooling water separately, since two different permissions and different discharge points.*

**** 280 MW between 01.06.-30.09.; 380 MW between 01.10.-31.05.*

***** Permitted thermal discharge during low water periods*

Development since 2009

Compared to the state on 31 December 2014, the sum of permitted thermal discharges in Germany has not notably changed in spite of the fact that some nuclear power plants in the Rhine catchment between Karlsruhe and Mainz have been switched off (Philippsburg Block I, Biblis, Neckarwestheim Block I). The reason is that the permissions have not been adjusted, e.g. because of their long terms or because the discontinued thermal discharges have been compensated by new discharge permits. As shown in Figure 9, since 2011, the switching off of power plants has led to detectably lower temperatures of the northern Upper Rhine at Mainz. Further power plants will be shut down in the years to come.

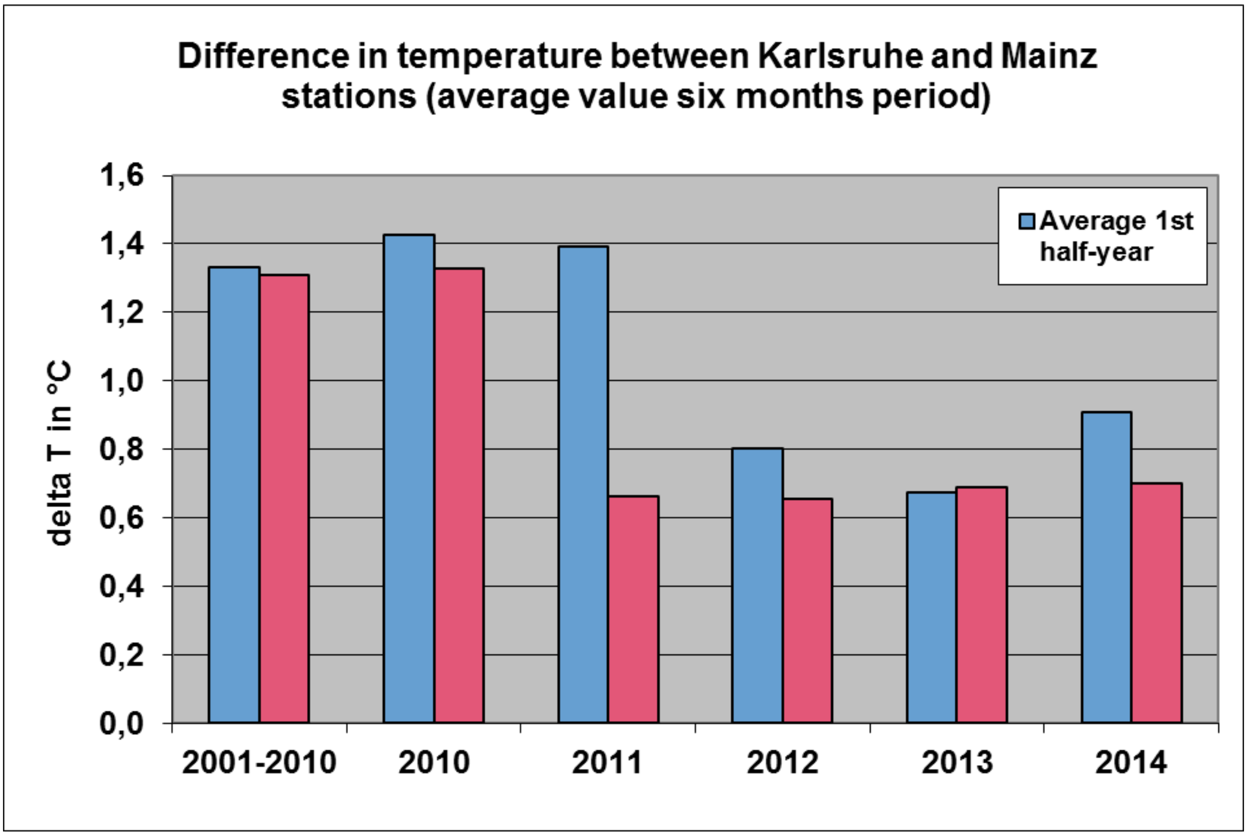

Figure 9: Difference in temperature of the average six months period between Karlsruhe and Mainz (graph: BfG)

Due to the combined effect of air temperatures and cooling water discharges, during particularly warm summers with extremely low discharges, water temperatures may rise to such an extent that a negative impact on the aquatic ecosystem is possible.

Due to water law limitations, the dischargeable waste heat is reduced with rising water temperatures, and when water temperatures rise above 28 °C, normally, no additional temperature discharges are allowed.

2.4 Effects of climate change - increased stress

The Conference of Rhine Ministers in 2013[21] had stated that Rhine water temperatures develop in parallel to increased air temperatures and that thus, in future, extreme situations, i.e. distinct periods of low flow will occur in summer, mostly in connection with high air temperatures and cause problems for the ecological functionality and the use (e.g. water supply, navigation) of water bodies.

Due to developments expected, more attention must thus be paid to the issue of low flow, in particular in summer and in connection with high water temperatures. For this issue, the ICPR has drafted a Strategy for Adapting to Climate Change for the IRBD Rhine for which regular updates are planned. [22]

In the Rhine catchment, considerable knowledge is available on the impacts of climate change observed during the 20th century on the discharge pattern of the Rhine and the development of water temperatures since 1978. Furthermore, during the last years, and based on climate projections, water gauge related simulations of the development of the

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[21] ICPR communiques, Conference of Ministers 2013

[22] ICPR report no. 219 (2015)

water balance[23] and the water temperature[24] in the river basin Rhine have been drafted for the near future (until 2050) and the distant future (2100).

According to these projections, the development until 2050 is characterised by a continuous rise in temperature which, on average, for the period 2021 to 2050 compared to the period 1961-1990 will amount to +1 to +2°C for the entire Rhine catchment.

For the winter, a moderate increase in precipitation is projected until 2050. Increased precipitation during the winter which, due to higher temperatures, will more often occur as rainfall than as snowfall, may lead to a moderate increase of medium and low flows and, downstream of Kaub, of flood runoff.

Projections for the summer do not indicate any clear trend for precipitation until 2050.

Due to rising air temperatures, the results of the model chains considered seem to indicate that floods and extreme events will occur more often in the river basin district, that is, that the water balance will distinctly change, and this development might become more marked towards the end of the 21st century. Also, higher air temperatures (a rise by +2 °C to +4 °C is projected for 2100) will lead to higher water temperatures.

The direction of change for the **water balance**, which, in the near future (until 2050) will partly still be moderate, becomes clear when considering what is expected for the end of this century:

a. During the hydrological <u>winter</u>:
  - Increased precipitation in winter
  - Increased discharge
  - Early melting of snow/ice/permafrost, shift of the line of snowfall

b. During the hydrological <u>summer</u>:
  - Less 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.

Simulations for the near future indicate that, compared to the reference situation, the number of days with **water temperatures** above 25 °C which are critical for certain fish communities will increase up to the double in periods of low flow (Qmin). In the distant future, there will be a strong rise in the number of days with temperatures above 25 °C. Similar statements also apply to the distant future for temperatures above 28 °C. Many alien species and the ubiquists among the invertebrates are fostered by the higher water temperatures. The effects of these changes on the biocoenosis in the Rhine, in particular on target species of the programme for migratory fish should be further observed. In future, the thermal pollution of the Rhine which has already diminished after certain nuclear power plants along the Rhine were turned off (see Figure 9), should thus be kept within a limit.

It is necessary to adapt water management to the possible effects of climate change. These measures must be considered in connection with climate change adaptation measures of other sectors and their possible interactions.

A study recently published by the international water protection commission for Lake Constance looks into the possible consequences of climate change on Lake Constance[25]. According to this study, climate change will increase water temperatures which will entail a modification in stratification and lead to reduced mixing of water layers. Less oxygen will

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[23] ICPR report no. 188 (2011)

[24] ICPR report no. 213 (2014); ICPR report no. 214 (2014)

[25] Climate Change on Lake Constance, IGKB report no. 60 (2015)

reach the deeper layers of the lake. The distinct nutrient reduction in Lake Constance will however contribute to a sufficient oxygen content at the bottom of the lake thanks to the low phosphorus content.

Further elements in connection with flood prevention are included in the first Flood Risk Management Plan for the IRBD Rhine, part A[26].

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[26] Flood Risk Management Plan

3. Register of protection areas

As required by the WFD, a register of all areas has been drafted for the IRBD Rhine, for which a particular need for protection has been stated according to the specific community legislation aimed at protecting surface waters and groundwater or to preserve biocoenosis and species directly depending on water. Like in the Management Plan 2009, three maps represent the water-dependent protected areas relevant for part A:

Map K 9: Abstraction of water for human consumption;

Map K 10: Fauna-Flora-Habitat areas depending on water – Natura 2000 (Directive 92/43/EEC);

Map K 11: Bird protection areas depending on water – Natura 2000 (Directive 79/409/EEC).

For Switzerland, these three maps indicate the corresponding areas based on national legislation.

- In K 10 Natura 2000 areas: Areas from the federal inventory of low moorlands[27] and the federal inventory of alluvial areas;[28]
- In K 11 Bird protection areas according to the federal inventory of reserves for water fowl and migratory birds.[29]

Measures concerning transboundary protection areas have been coordinated. Concerning the other protection areas, please refer to the Part B reports.

Development since 2009

(Figures without Switzerland)

Since the Management Plan 2009, the number of recreational and bathing waters, just as the number and surface of bird protection areas, have slightly increased (Table 6). The surface of 18,336 km² (1,007 km² more than in 2009) has increased by 398 km of linear bird protection areas mostly located along waters.

The number of Natura 2000 areas is slightly reduced, which may be due to restructuring measures when designating areas (integration of several smaller, similar areas to one larger area). However, the surface has increased by 2,193 km².

The total area of water-dependent Natura 2000 areas in the IRBD has increased by 3,199 km² and is now 35,438 km² (which is about 18.5 % of the total surface of the IRBD Rhine, i.e. 1.5 % more than in the beginning of 2010).

The total surface of water protection areas amounts to 23,496 km². This surface does not include groundwater bodies in the Netherlands from which water is abstracted for human consumption, a surface which amounts to further 19,579 km². The considerable reduction of the number of water protection areas since 2009 is due to the fact that, in 2009, partly individual abstraction points (point data) were reported, while, in 2015, only surface data were reported (that is, areas of protection where normally several abstraction points are located).

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[27] http://www.bafu.admin.ch/publikationen/publikation/00878/index.html?lang=de

[28] http://www.bafu.admin.ch/publikationen/publikation/00884/index.html?lang=de

[29] http://www.bafu.admin.ch/publikationen/publikation/01633/?lang=de

Table 6: Development of the number and surface of protection areas in the IRBD Rhine
Figures without Switzerland.

	22/03/2010 (1st Management Plan)	**12/10/2015** (2nd Management Plan)
Water protection areas - number	27,683	9,016
Total surface of water protection areas (km²)		23,496
Surface of groundwater bodies in the Netherlands from which water is abstracted for human consumption (km²)		19,579
Recreational and bathing waters - number	985	1,079
Bird protection areas - number	383	386
Natura 2000 areas - number	1,414	1.335
Bird protection areas - surface (km²)	17,329	18,336
Natura 2000 areas - surface (km²)	14,909	17,102
Total surface of water-dependent Natura 2000 areas (km²)	32,239	35,438
in % of the total surface of the IRBD Rhine	17	18,5

Partly, this positive development is certainly due to a synergy effect of the environmental objectives of the WFD and the provisions of the above mentioned directives.

Also, the connection with the implementation of the Floods Directive (FD) which entered into force in 2007 must be taken into account.

All measures retaining water in the entire catchment and along the Rhine and which locally enhance natural seepage, that is the renaturation of rivers, the reactivation of floodplains, the extensification of agriculture, nature development, afforestation and unsealing serve the objectives of flood prevention and improve the quality of groundwater and surface waters. At the same time, these measures will contribute towards improving the habitats for the flora and fauna living in the water, on its banks and in the floodplains.

4. Surveillance networks and results of surveillance programmes

Water bodies must be controlled regularly in order to check their condition. Furthermore, this surveillance shows whether improvement measures are proving successful in respect to the most important management questions.

For the basic network of water bodies of the Rhine, the ICPR, ICPMS, the International Commission for the Protection of Lake Constance (IGKB) and the Deutsche Kommission zur Reinhaltung des Rheins [German Commission for Keeping the Rhine Clean] (since 2011 the river basin community (FGG) Rhine) have agreed upon and been implementing an international chemical monitoring programme since 1950 and a biological monitoring programme since 1990. Within the Rhine Monitoring Programme Chemistry and Biology 2012/2013 according to the WFD, the chemical and physical parameters as well as the biological quality elements have been analysed.

The internationally coordinated surveillance monitoring programme has been presented in a joint summary report on the coordination of the surveillance monitoring programmes (part A)[30]. During 2012 and 2013, the surveillance monitoring programme was again conducted for the 2nd cycle of the WFD.

4.1 Surface waters

According to the requirements of the WFD, surface waters (rivers, lakes, transitional and coastal waters) must, as a matter of principle, achieve the “good” status by the end of 2015. If designated as artificial and heavily modified waters, they must achieve a “good ecological potential” and a “good chemical status”.

The surveillance network to monitor the ecological and chemical status were established on schedule by 22 December 2006.

Map K 12 indicates the locations of the monitoring stations for the biological surveillance monitoring of the basic network of water bodies (catchment area > 2,500 km²). Map K 18 indicates the location of the 56 monitoring stations for the chemical and physico-chemical surveillance monitoring, that is for the physico-chemical elements, the substances relevant for the Rhine, the priority substances according to the Directive 2008/105/EC in the version of the Directive 2013/39/EU for the basic network of waters (catchment area > 2,500 km²). The criteria for the choice of these monitoring stations indicated in the maps K 12 and K 18 and which are taken into account in the Management Plan Rhine Part A were a) monitoring station in the main stream, b) outlets of large tributaries of the Rhine and c) survey over the ramified delta area. In salt water, control of the ecological status is limited to the coastal waters, i.e. to the 1-mile-zone. The determination of the chemical status extends as far as the 12-mile-zone.

4.1.1 Ecological status / ecological potential

Mainly, the ecological status resp. the ecological potential is determined by the biological quality elements (phytoplankton, macrophytes, phytobenthos, macrozoobenthos, and fish). Furthermore, hydromorphological and general physico-chemical elements must be taken into account.

In the following, a survey over the classification of the individual biological quality elements and of the supporting physico-chemical parameters during 2012/2013 is given for level A. Annex 1 and 2 present the classifications for the monitoring stations in the surveillance monitoring network of part A.

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[30] Surveillance programme (2007)

Chapter 5.1.1 includes statements on the “good ecological potential” (GEP) to be achieved by 2015 instead of the “good ecological status” if water bodies are classified as heavily modified or artificial.

All Member States, resp. federal states or regions have determined the criteria for the classification of the ecological status resp. potential according to WFD Annex V for each type of water body/water and for each relevant quality element.

Map K 17 presents the national classification of the present ecological status or potential of surface water bodies in the IRBD Rhine (basic network of water bodies, catchment area > 2,500 km²). The classification must identify values in excess of the environmental quality standards for river basin specific pollutants if these are decisive for not achieving the good status/potential (representation on the map: black dot in the water body). This means that, if all four biological quality elements are classified as “good” and the physico-chemical parameters are not good, the total classification will be “moderate”. This case does not apply to any of the surface water bodies of the basic network of water bodies in the IRBD Rhine.

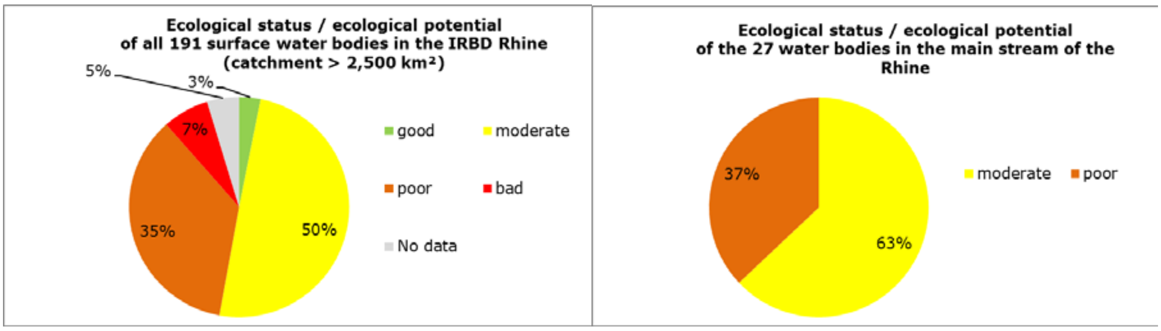

Figure 10: Ecological status / ecological potential of all surface water bodies in the IRBD Rhine (catchment area > 2,500 km², left) and of water bodies in the main stream of the Rhine (right) based on the number of water bodies. State: December 2015; data excluding Switzerland, see below

Figure 10 shows the present ecological status / the ecological potential expressed in per cent based on the number of water bodies for the entire water network at level A (left) and for the main stream of the Rhine (right; data basis: biological monitoring programmes 2011 / 2012). Thus, at present, 3 % of the water bodies have a good status; half of the water bodies were classified as moderate, the rest of them as below moderate. For 5 % of the water bodies there is no information available. In the main stream of the Rhine, 63 % of the water bodies were classified as moderate, 37 % as poor.

Switzerland as non EU member state does not delimit water bodies and does not classify them according to the WFD criteria. Within international data exchange, Switzerland reports “reporting units” to the European Environment Agency (EAA) (see maps). These Swiss data were not taken into account during the statistical evaluation (pie charts).

Annex 1 shows the present comprehensive ecological classification of the water bodies with monitoring stations of the ecology surveillance network as compared to the Management Plan in 2009.

Biological quality elements

A co-ordinated investigation of the biological quality elements was carried out[31] for the **main stream of the Rhine**. In the following, an assessment of the analysis results for each biological quality element of the individual sections of the Rhine is outlined.

Phytoplankton[32]

Plankton designates mostly microscopic small organisms floating in the water. Apart from the phytobenthos and the rest of the aquatic flora, the phytoplankton belongs to the important primary producers. Under certain circumstances, phytoplankton may bloom in great rivers and thus cause the well-known eutrophication and impact water quality. However, not all states have determined ecological objectives according to WFD for the phytoplankton. The reason is that the residence time of phytoplankton in rivers is comparatively short. Excessive algal bloom is a good eutrophication indicator. However, if no excessive algal bloom occurs, this does not necessarily mean that there is no eutrophication. In waters which come to a standstill and where the residence time increases, there is an increased probability of eutrophication, e.g. in cut-off river branches, in lakes, in coastal and transitional waters.

In 2012, within the Rhine monitoring programme ‘Biology’, the phytoplankton of the Rhine was analysed from Lake Constance to the Rhine delta. The target of the monitoring programme is to record the development of the phytoplankton in space and time. At the same time, it corresponds to the requirements of the EU Water Framework Directive to classify the ecological status or the ecological potential of the Rhine on the basis of the phytoplankton and of other biological elements.

The species composition of the **phytoplankton** and increasing biomass indicate the nutrient contamination of a water body. In the river section between Lake Constance and Karlsruhe, the biomass of the phytoplankton measured as chlorophyll a content and bio-volume was very low. With respect to phytoplankton, the status of the entire High Rhine and of parts of the Upper Rhine is “high”. Downstream of the Karlsruhe monitoring station the biomass gradually increased, and the tributaries Neckar, Main and Moselle contributed with comparatively high concentrations of phytoplankton. Due to dilution effects, these sections of the Rhine can nevertheless be classified as “good” and the same applies to the Lower Rhine at Cologne and Düsseldorf. The maximum concentration of phytoplankton biomass was achieved on the Lower Rhine at the monitoring stations Bimmen / Lobith near the German-Dutch border. Downstream the Duisburg monitoring station, the status of the Lower Rhine is moderate. In the course of the Delta Rhine, the phytoplankton biomass slightly decreased. Here, the rivers were not classified with respect to their phytoplankton concentrations.

The by far largest phytoplankton share is made up of centric diatoms (diatoms); cryptomonads (Cryptophyceae) and green algae (Chlorophyceae) figure among the further important groups of algae. Other groups were only of temporary or local importance.

Animal plankton (zooplankton) feeding on phytoplankton was inventoried from the northern Upper Rhine until the Lower Rhine. It equally increased on the way downstream but only to a small extent. Therefore, its decimating influence on the phytoplankton is estimated to be of little importance. Rotifers were most frequent among the zooplankton, at times also freely swimming mussel larvae played an important role.

In 2012, the phytoplankton biomass proved to be slightly above that during the monitoring programmes in 2000 and 2006/2007 (see Figure 11). Considering the long-term trend and compared to the data of the 1980s, the phytoplankton biomass however

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[31] ICPR report no. 232 (2015)

[32] ICPR report no. 224 (2015)

remains on a low level. This long-term trend correlates to the reduction of the nutrient pollution and of phytoplankton input from Lake Constance, but presumably a certain share is due to filtration activities of immigrated mussels.

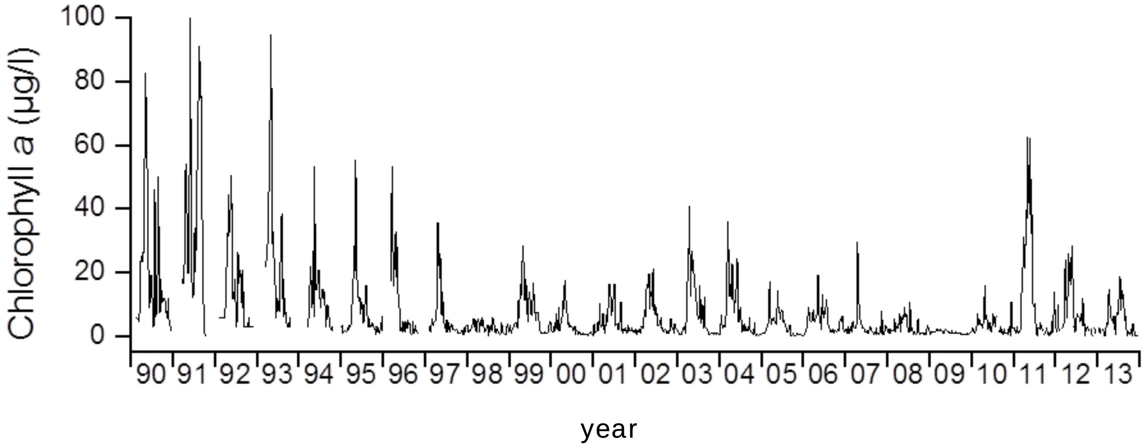

Figure 11: Development of the chlorophyll a concentration at the Koblenz monitoring station since 1990. Data: Bundesanstalt für Gewässerkunde (BfG)

Phytoplankton in coastal and transitional waters

For the coastal and transitional waters, phytoplankton is the most important biological quality element indicating eutrophication and is classified according to its biomass (as chlorophyll a) and its taxa composition (only algae of the genus *Phaeocystis*)[33]. *Phaeocystis* indicate eutrophication at an early stage and thus serve as early warning system.

Even though the concentrations are in excess of the Dutch guidance value of 0.46 mg DIN/l at a salinity of 30 (DIN = Dissolved Inorganic Nitrogen), the phytoplankton on the Dutch coast has achieved a good status (see Table 7). During the past years, the status of the Wadden Sea coast and of the Wadden Sea has been less stable and has, depending on the monitoring station, achieved a poor to good status and an overall moderate to good status.

Map K 13 represents the results of the present national classification of phytoplankton in the IRBD Rhine (basic network of water bodies, catchment area > 2,500 km²) according to the WFD.

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[33] VAN DER MOLEN 2012: Referenties en maatlatten voor natuurlijke watertypen voor de Kaderrichtlijn Water 2015-2021. STOWA 2012-31

Table 7: Final classification (minimum of Chl or of the average value of Chl and *Phaeocystis*) of the phytoplankton quality element based on the Dutch classification system.[34]

Monitoring station	**Water body**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Noordwijk 2	Dutch Coast	0.76	0.54	0.53	0.61	0.84	0.62	0.86	0.55	0.60	0.81	0.64	0.66	0.92	0.61	0.80
Boomkens-diep**	Wadden Sea coast	0.71	0.64	0.75	0.63	0.49	0.39	0.85	0.60	0.52	0.63	0.66	0.46	0.68	0.55	0.51
Dantziggat	Wadden Sea east	0.48	0.41	0.48	0.47	0.47	0.54	0.51	0.52	0.24	0.52	0.44	0.50	0.48	0.38	0.52
Doove Balg West	Wadden Sea west							1.00	0.56	0.69	0.61	0.74	0.65	0.72	0.62	0.71
Marsdiep Noord	Wadden Sea west											0.68	0.56	0.74	0.37	0.70
	Wadden Sea total	0.48	0.41	0.48	0.47	0.47	0.54	0.76	0.54	0.47	0.57	0.62	0.57	0.65	0.55	0.61

** Until 2007 Terschelling 4

Legend: Ecological status / ecological potential

High	🟦
Good	🟩
Moderate	🟨
Poor	🟧

Macrophytes (aquatic plants)[35]

Aquatic **macrophytes** (aquatic plants) may equally be used to assess the nutrient pollution of flowing waters; however, they also distinctly react to interferences with the flow regime (e.g. impoundment) and reflect the structural conditions of a water body (substrate diversity and substrate dynamics, extent of engineering of the river bank and the river bottom). Within the Rhine Monitoring Programme Biology, the partial component macrophytes was considered independently of the algal growth (phytobenthos). So far, no reference for aquatic water plant communities of the Rhine can be described, so that no classification in conformity with the WFD is possible. The classifying statements are based on an initial expertise of individual monitoring stations taking into account the number of species and growth forms, the occurrence of quality indicators and the degree of vegetation cover.

In 2012/2013, 44 aquatic macrophyte species were detected at 49 monitoring stations in the main stream of the Rhine: 27 higher plants, 13 mosses and 4 stoneworts. *Potamogeton pectinatus* (fennel pondweed, 25, see Figure 12) was most common, followed by *Myriophyllum spicatum* (spiked water-milfoil, 20) and *Fontinalis antipyretica* (common water moss, 16). Some species which were still observed in 2006/2007 were no longer detected, among them 3 stoneworts. Twenty species, among them 5 mosses and the various-leaved pondweed *Potamogeton gramineus* rarely occurring in the Rhine area were detected for the first time. A different method allowing to detect mosses more easily, the extensive spreading of the broom fork moss *Octodiceras fontanum* in Germany and a discharge situation on the Upper Rhine during the year of investigation 2012 enhancing pond weeds (*Potamogeton* spp.) range among the possible reasons. In 2013, Nuttall's waterweed (*Elodea nuttallii*), a neophyte which has rapidly spread in Middle Europe since the middle of the last century, was detected in the Upper and Middle Rhine, but no longer in the High Rhine.

In the High Rhine, 3 sampling stations presented a cover of aquatic vegetation below 2 %, which may be due to methodical reasons or floods or unfavourable discharge

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[34] Eutrophication is one of the descriptors of the "good status of the marine environment" of the Marine Strategy Directive (MSFD). Within the OSPAR, the EU Member States with marine waters in the Northeast Atlantic and the European Commission have agreed upon a joint classification to serve as a basis for their national reporting obligations. With respect to the OSPAR indicator, the presence or not of extreme *Phaeocystis* bloom is applied as a classification criterion, while, for the requirements of the WFD, the period during which **Phaeocystis** bloom occurs is decisive. The OSPAR classification within the MSFD is planned for 2017.

[35] ICPR report no. 225 (2015)

conditions. Most sampling stations along the Upper and Middle Rhine showed a cover of more than 2 %. The macrophyte stocks of the Upper Rhine are heterogeneous; some have considerable deficits, others are well developed. The 3 sampling stations on the Middle Rhine are rich in species and growth forms. During the investigation period, the sampling stations Bacharach (Middle Rhine, km 542) and Langenaue (Upper Rhine, km 490) showed the most well developed macrophyte stocks in the entire course of the Rhine with 17 resp. 14 species and 7 growth forms each.

In the Lower Rhine, only 1 to 2 species were detected with a low percentage of cover. Most sampling stations in River Waal in the Delta Rhine were exempt of aquatic macrophytes in 2006/2007 and 2013 and are thus classified as presenting "heavy deficits". However, sampling stations in the Dordtse Biesbosch, the Oude Maas and Lake IJssel were more species-rich. The coastal and transitional waters are evaluated on the basis of seaweeds and common salt marshes (quality and quantity). The mainland coast of the Wadden Sea was classified as moderate, the Wadden Sea as poor. The Dutch coast and the coast of the Wadden Sea belong to another type to which a classification based on seaweeds and common salt marshes cannot be applied, as these plants do not naturally occur there.

The observed heterogeneous spreading of macrophytes in space and time in the Rhine (see Figure 13) may be explained by (a) a difficult representative recording, (b) variations of the discharge situations during the monitoring years and (c) the local occurrence of favourable river bank structures (e.g. protected groynes with favourable substrate).

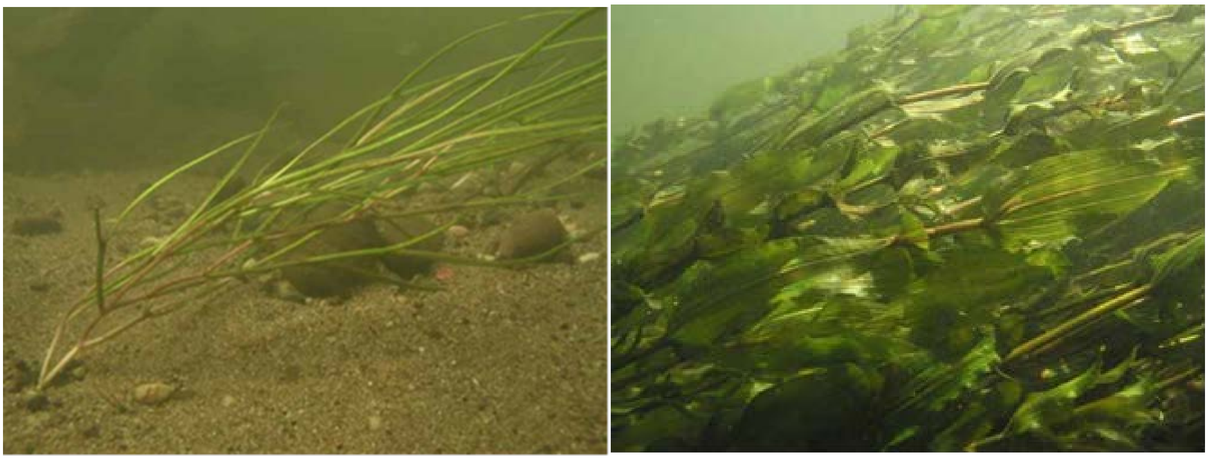

Figure 12: Macrophytes (water plants) in the Rhine.
Left: Fennel pondweed (*Potamogeton pectinatus*). In 2006/2007, the fennel pondweed was still detected in all sections of the Rhine (from the High Rhine to the Delta Rhine). In 2013, the species only occurred in the Upper and Middle Rhine.
Right: Perfoliate pondweed (*Potamogeton perfoliatus*). The species occurs in the Upper and Middle Rhine. It disappears during more intensive eutrophication (photos: K. van de Weyer).

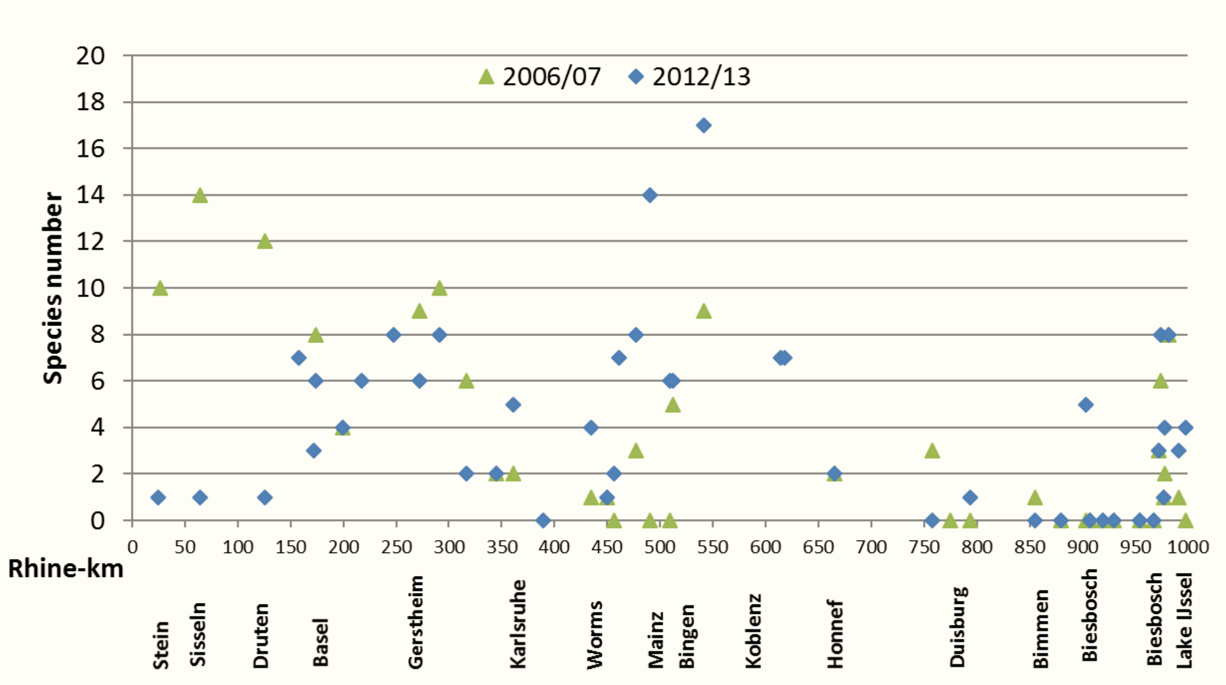

Figure 13: Number of aquatic macrophyte species at the sampling stations in the main stream of the Rhine and the Rhine delta during the investigations in 2006/2007 and 2012/2013

Phytobenthos[36]

Phytobenthos (above all benthic diatoms = bacillariophyta) reacts to changes in water quality with characteristic shifts of species composition and species frequency, and indicates nutrient and salt pollution, saprobity and the state of acidity in the water body. During 2012/2013, 306 species of benthic diatoms were detected at the 47 analysed sites. This corresponds to a considerable species diversity even for a big river such as the Rhine. However, many species only occur at few sampling stations, while a comparatively low number of species (25) occurs at over 50 % of the sampled sites. Figure 14 shows the abundance, that is the number of individuals of 4 common benthic diatoms in the Rhine in one sample (see also photos in Figure 15).

The bioceonosis of diatoms with certain indicative characteristics (so-called guilds) occurring in the Rhine reflects decreasing flow velocity and in parallel increasing nutrient contents and organic substances: The species composition of the High Rhine is typical of running waters with few nutrients and organic substances. From the Upper Rhine until the delta, species typical of nutrient-rich habitats represent a considerable share. In addition, planktonic and halophile (salt-loving) species occur in the Rhine delta.

In 2012, all parts of Lake Constance were classified as “good”[37], just as the entire High Rhine and the southern Upper Rhine until the Gambsheim impoundment.

The further course of the Rhine (northern Upper Rhine, Middle Rhine) until the German-Dutch border is classified as moderate with one “poor” water body in the Lower Rhine (upstream mouth of River Ruhr).

In the Delta Rhine, numerous water bodies, among them the IJssel have achieved the good ecological potential with respect to the quality element macrophytes / phytobenthos. Some water bodies in the Delta Rhine where classified as moderate, one single water body near Rotterdam as poor. See above for the classification of the coastal and transitional waters and for the Wadden Sea (section “Macrophytes”).

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[36] ICPR report no. 226 (2015)
[37] Management Plan Alpine Rhine / Lake Constance

As benthic diatoms were first investigated and evaluated by the Rhine Monitoring Programme 2006/2007, no statement can be made with respect to the long term trend of this group. It is however undeniable that - comparable to the phytoplankton situation - the reduction of the nutrient pollution of the Rhine has resulted in a more natural biocoenosis.

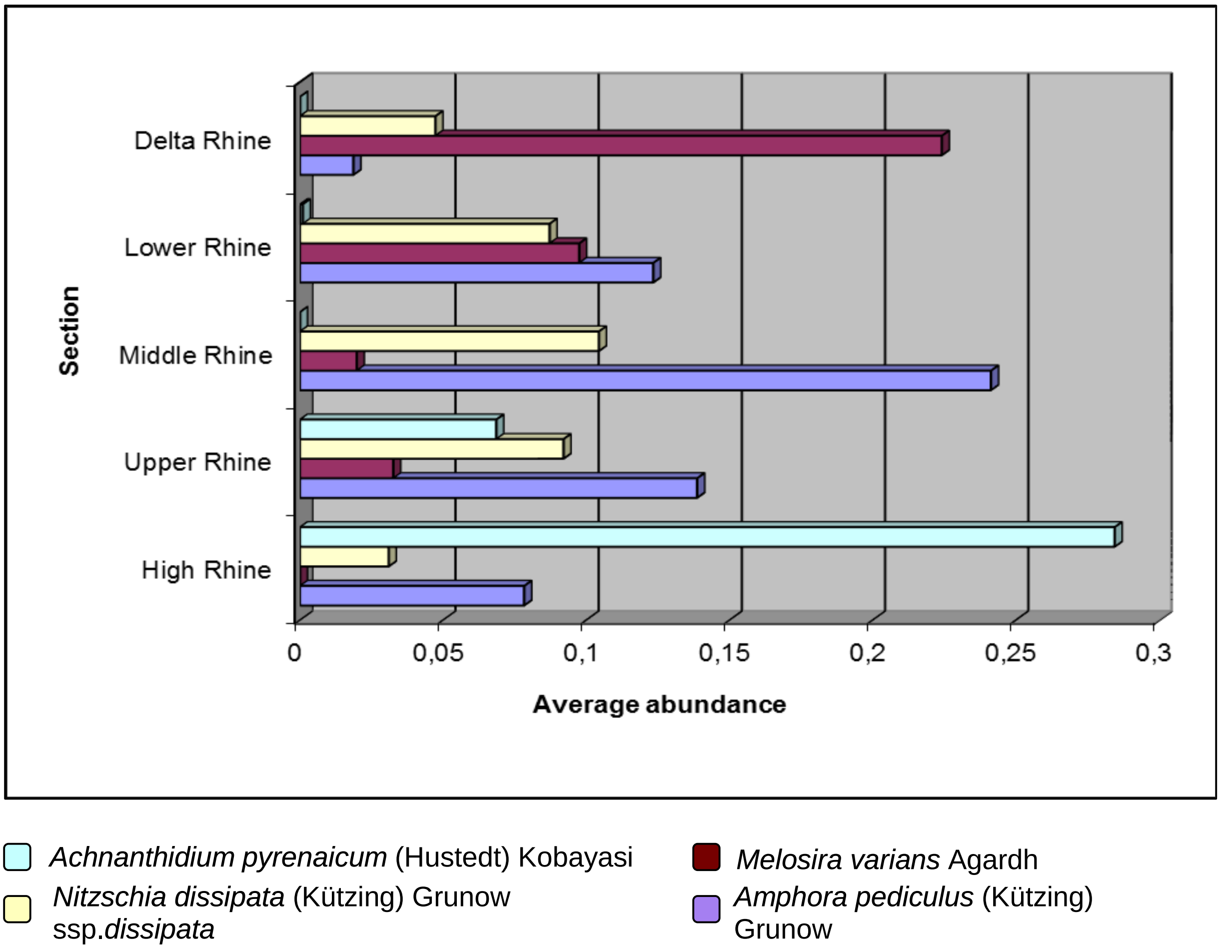

Figure 14: Average abundance of four aspect-forming species of benthic diatoms in the sections of the Rhine

Achnanthidium pyrenaicum is a pollution-sensitive species with great abundance in the High Rhine.

Melosira varians is a benthic tychoplankton species which means that it is typical of eutrophic (nutrient-rich) standing waters and represents a large share in the samples from the lower river section.

Nitzschia dissipata: As most representatives of this genus, the species belongs to the "mobile" guild capable of moving rapidly and adapted to habitats with turbulent waters and high nutrient concentrations.

Amphora pediculus is classified as β-mesosaprobic and is considered to be euryoecious and ubiquitous which means that the species prefers moderately nutrient-rich waters and tolerates different habitat conditions so that it occurs almost everywhere. It is a pioneer species in habitats with strong biofilm grazing (e.g. by invertebrates or fish).

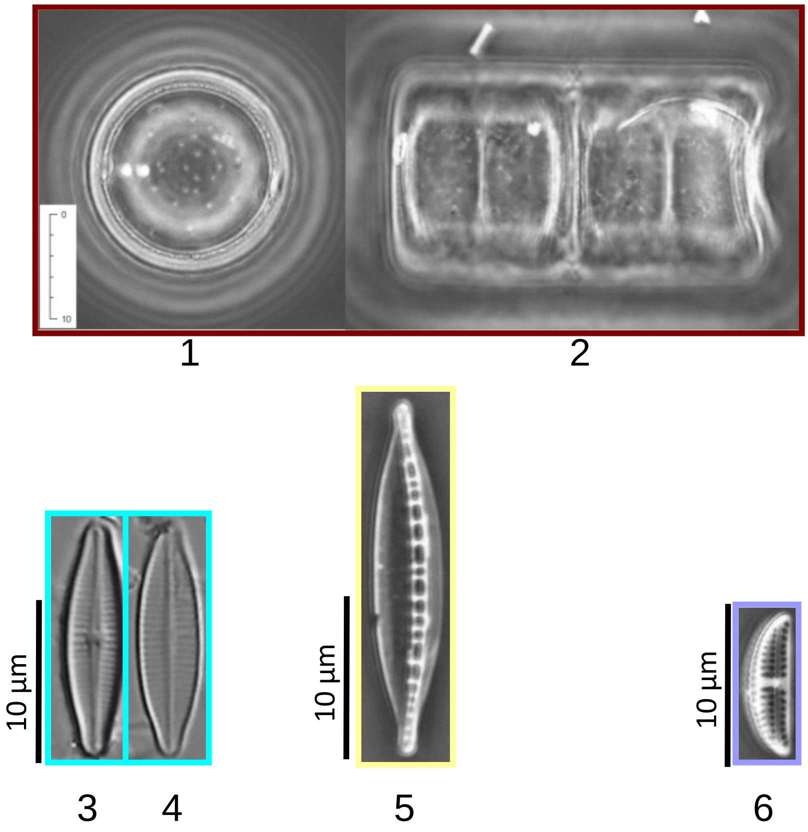

Figure 15: Photos of four aspect-forming species of benthic diatoms in the sections of the Rhine. 1-2: *Melosira varians* top view (1) and side view (2); 3-4: *Achnanthidium pyrenaicum*; 5: *Nitzschia dissipata*; 6: *Amphora pediculus;* photos D. Heudre.

Map K 14 presents the results of the latest national classification of the biological component macrophytes/phytobenthos/angiospermae in the IRBD Rhine according to the WFD (basic network of water bodies, catchment area > 2,500 km²).

Macrozoobenthos (invertebrates living on the river bed)[38]

Depending on its species composition, dominance relationships and the presence of alien species (originating from other regions) the **macrozoobenthos** (invertebrates living on the river bottom) serves as an indicator for water quality and structural conditions in the water body. All in all, more than 500 **macrozoobenthos species** were detected in the Rhine between the Alps and the North Sea. Above all molluscs (mollusca), oligochaeta, crustaceans, insects, freshwater spunges (spongillidae) and bryozoa make up the aspect. The macrozoobenthos composition in the Rhine is closely linked with the pollution of the river water. Until the beginning of the 1970s, the number of species typical for the Rhine drastically diminished as the effluent load of the Rhine rose. From the middle of the 1970s, many characteristic river species returned as oxygen contents improved due to the construction of wastewater treatment plants. While the total number of species remained unchanged in the navigable Rhine for 15 years, the average number of species per monitoring station has been strongly regressing since 1995. A possible reason might be the increased spreading of **alien species** in the Rhine. These non-indigenous species which, since 1992, have above all been introduced into the Rhine via the Main-Danube Canal, settle in the main stream and the tributaries, often in great biomasses and, attached to ship, even spread upstream – and often the indigenous fauna pays the toll. However, monitoring shows that, in some sections of the Rhine, the species number is

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[38] ICPR report no. 227 (2015)

also liable to increase. The reason for this development is to be found in ecological interactions due to migration processes.

In the Anterior and Posterior Rhine and in the Alpine Rhine, rheophile insect species, that is larvae of mayflies, stone flies and trichoptera typical for the system of the Alpine Rhine are dominant. The macrozoobenthos of the investigated sections of the Alpine Rhine is heavily influenced by structural and hydrological deficits. The hydropeaking of hydropower plants in the Alpine Rhine considerably impact the species number, species composition and abundance of individuals. Nevertheless, different rare species occur along the investigated section of the Rhine and none of the alien species which have been introduced into the other sections of the Rhine have so far been able to invade the lower Alpine Rhine, resulting in a good classification of the Alpine Rhine.

Lake Constance being a still water has its own fauna composition distinctly different from that of the Rhine.

While the Anterior Rhine, the Posterior Rhine and the High Rhine are considered to be natural water bodies, the Alpine Rhine as well as all water bodies from the Upper Rhine to the Delta Rhine are classified as heavily modified or artificial. The development target for non-natural water bodies is not the good ecological status but the good ecological potential.

The High Rhine is species-rich, the macrozoobenthos community is nature near. In spite of alien animal species, the status until upstream of the mouth of River Aare can be considered to be good, further downstream until Breisach on the southern Upper Rhine as moderate.

Downstream of Basel, the natural longitudinal segmentation of the Rhine is strongly impacted by anthropogenic interferences. In the navigable and trained Rhine (Upper, Middle, Lower and Delta Rhine), the benthic fauna is largely uniform and is – apart from alien species - dominated by common and frequent colonisers of bigger rivers and streams with little demands on their habitats (ubiquists). Elements of the original fauna are partly found in connected oxbow lakes and in the loops of the original course of the Rhine.

While the potential of the Upper Rhine sections between Breisach and Strasbourg and between Karlsruhe and the mouth of River Neckar have been classified as poor, that of the sections between Strasbourg and Karlsruhe and the sections downstream the mouth of River Neckar until Mainz are classified as moderate. Downstream of Mainz, the northern Upper Rhine and the entire Middle Rhine have achieved the good ecological potential. In these sections, the share of alien species has fallen, while that of indigenous species has risen. Within this development, the immigration of indigenous species from tributaries may play a role.

In the Lower Rhine until Cologne, the potential has been classified as moderate, from there on and until the Dutch border as poor.

The sandy substrate of the Delta Rhine is above all colonised by chironomidae, oligochaetes and mussels while, on hard substrates, a biocoenosis similar to that of the Lower Rhine is found. In the Delta Rhine near the coast, the fauna is composed of brackish and marine water species.

The arms of the Rhine and the Hollandse IJssel have been classified as poor, while most of the other water bodies in the Delta achieve a better classification: Nederrijn / Lek, the Randmeren, Markermeer, Wadden Sea and Dutch coast are moderate; IJsselmeer, Nieuwe Waterweg and the coast of the Wadden Sea are good.

Alien species

Alien species are non-indigenous animal species orignating from other regions. In particular after the accomplishment of the Main-Danube-Canal in 1992, organisms from the Lower Danube area and the Black Sea immigrated into the Rhine. Attached to ships, they even spread against the current in the Rhine. In the 1990s, this entailed a re-structuration of the biocoenosis. With respect to dominance (= relative abundance of a species compared to the other species and with respect to a certain size of habitat) and constancy (= relative distribution of a species compared to the other species and with respect to a certain size of habitat) alien species moved into the front positions. Original Rhine species (e.g. *Hydropsyche* sp.) or former alien species (e.g. *Gammarus tigrinus)* have been replaced.

The list of alien species among the invertebrates detected in the Rhine between 2001 and 2012 has been completed by some brackish water species, resp. marine species from the Delta Rhine to include 46 species, 23 of which are crustaceans.

The four alien mussel species in the Rhine have been thoroughly investigated. Since 2006, the quagga mussel *Dreissena rostriformis bugensis* originating from the northwest of the Black Sea and its tributaries is increasingly spreading in the Rhine area and locally achieves an abundance of far more than 1000 individuals/m². The strategies concerning habitat, feeding elements and reproduction of zebra mussel *D. polymorpha* occurring in the Rhine for more than 100 years and that of the quagga mussel are similar. Parallel to the spreading of the quagga mussel there are less occurrences of the zebra mussel.

The basket clam *Corbicula fluminea* originating from Australasian fauna regions began to spread in the Rhine at a time during the middle to end of the 1980s when temperatures rose. This development is seen in connection with human induced climate change and the rise of Rhine water temperatures. Periods with temperatures below 2 °C are considered to be critical for *Corbicula*; also, after cold periods in winter, mussel reproduction is reduced. Days with Rhine temperatures below 2 °C have become rare. An average abundance of *C. fluminea* of more than 500 individuals/m² is not rare and locally, particularly downstream of warm water discharge points, an abundance of more than 1000 individuals/m² can be observed.

Already Lauterborn (1916-1918) described the widespread occurrence of the river nerite *Theodoxus fluviatilis* in the Upper Rhine and Middle Rhine. While the species disappeared, when the pollution of the Rhine reached its peaks, it was again detected in several sections of the Rhine between 1988 and 1992, partly with great abundance[39]. After 1995, the river nerite largely disappeared from the Rhine, probably under the influence of the heavily increasing dominance of alien species, in particular of the omnivorous crustacean *Dikerogammarus villosus*. In May 2006, *T. fluviatilis* was again detected downstream the mouth of River Main and spread during the following years. In 2012 it had settled in the entire section of the Rhine between Worms and Koblenz, while it was detected once near Basel (Figure 16).

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[39] ICPR report no. 74 (1996): The Macrozoobenthos of the Rhine 1990-1995. - Editor Franz Schöll (BfG), ICPR report of the WG Ecology, 27 p + Annex.

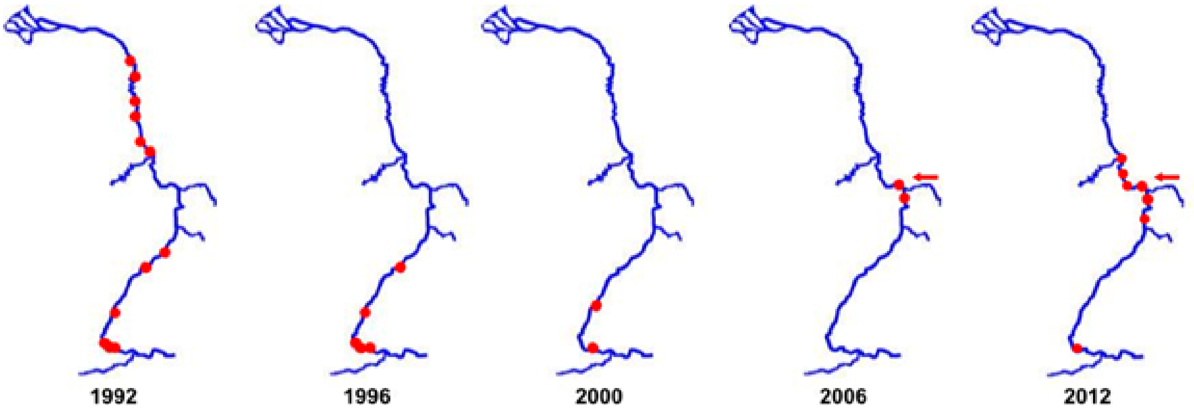

Figure 16: Spreading of the river nerite *Theodoxus fluviatilis* in the navigable Rhine (Westermann et al. 2007, complemented), without taking into account the occurrence in side waters

The assumption that the recolonisation of the Rhine originates from the stable stocks of the river nerite in River Danube has now been substantiated by genetic analysis: The form occurring in the Black Sea is genetically different from the form originally occurring in the Rhine and may thus be designated as “cryptic alien species”. But, from an ecological point of view, there is no reason to classify the “new” species in the Rhine different than the “old” one, as it belongs to the same type of life form.

At the mouth of the River Main, the abundance of the *Ancylus fluviatilis* sank after 2007, when *Theodoxus* started recolonizing from the Danube (Figure 17). This relationship has also been stated in the Slovakian Danube[40]. Both species claim similar ecological niches.

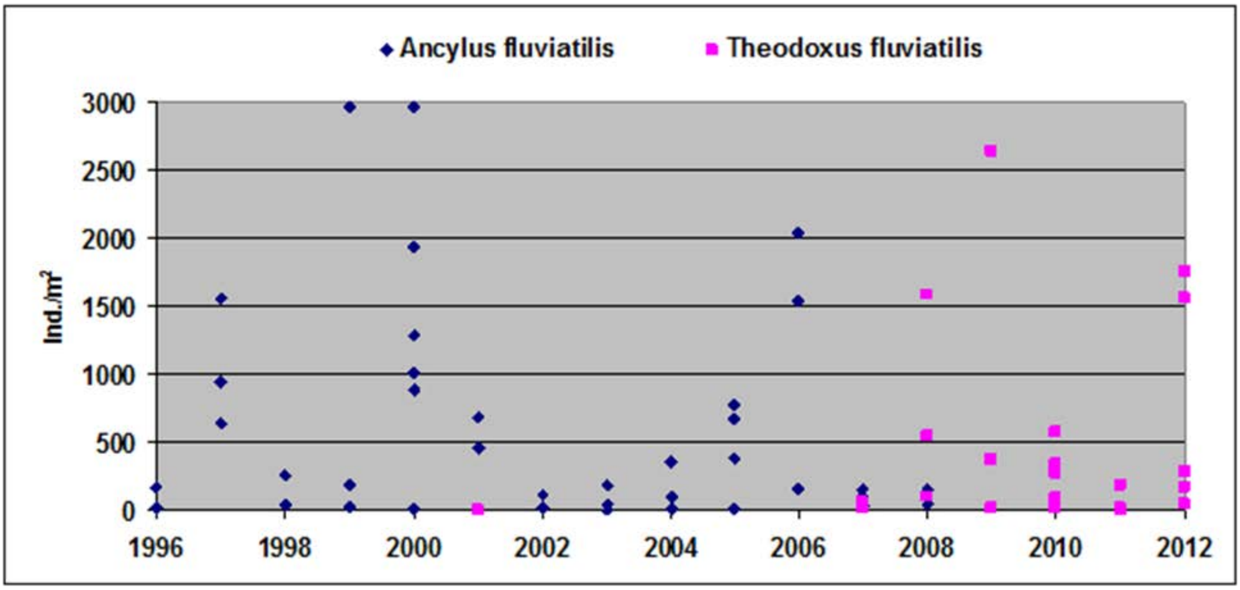

Figure 17: Abundance of *Theodoxus fluviatilis* and *Ancylus fluviatilis* in the Rhine in the area of the mouth of River Main, Rhine km 492-496. Graph: F. Schöll, BfG

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[40] Kosel, V. (2004): *Theodoxus fluviatilis* (Gastropoda) – nový inválzny druh v strednej Európe? Zoologické dny Brno 2004, Sborník abstraktů z konference 12.-13. února 2004. p. 51

Figure 18: River nerite *Theodoxus fluviatilis* (left) and *Ancylus fluviatilis* (right). Photos: B. Eiseler

Map K 15 shows the latest national assessment of the benthic invertebrate fauna (macrozoobenthos) in the IRBD Rhine according to WFD (basic network of water bodies, catchment area > 2,500 km²).

Fish[41]

The species composition, abundance and age structure of fish indicate structures of large areas, river continuity, modifications of discharge (e.g. impoundment, water intake, diversion) and thermal pollution. Today there are 64 fish species (including cyclostomata such as river and sea lamprey, see Figure 19) in the Rhine, which corresponds to a considerable species diversity in the river between the coast of the North Sea and Strasbourg. Apart from the European Sturgeon, all historically proven species were again detected during the fish-stock survey conducted in 2012/2013. In many places, results of electro fishing are dominated by alien goby species, above all the round goby which largely prefers the riprap of the river banks. [42] Furthermore, mostly ecologically euryoecious species such as roach, bream, chub (see Figure 19), perch and bleak are found.

The greatest number of fish species is found in the Upper Rhine and the Delta Rhine. On the one hand, this result is explained by the high density of sampling stations, on the other hand it is due to the special make-up of the biocoenosis in these sections. In the Upper Rhine, the alluvial areas of the Rhine rich in water plants contribute to this result, in the Delta Rhine the brackish water habitats and Lake IJssel. In particular along the Upper Rhine and the Middle Rhine (above all in the oxbow lakes and the groynes of the main stream) the vegetation of macrophoytes has considerably increased. This development furthers the reproduction of rheophile species. Juvenile fish habitats are thus available for many further species.

25 species have been inventoried in the High Rhine. Spirlin, chub, roach and bream were predominant. Nase, bullhead and eel frequently occur. According to a special investigation aimed at inventorying the stocks of juvenile fish, the share of alien species (stone moroko, goldfish, bighead goby, sunfish and pike-perch) remains comparatively low at 14 %. 31 species were identified in the southern Upper Rhine. From here on, the dominance of alien goby species already begins. More than half of the individuals caught are round gobies and bighead gobies, which are followed by less demanding species such as chub, roach, three-spined stickleback, stone loach and bleak. In the reservoirs, there are no habitats for rheophile species such as the nase which rarely occurs. In spite of potentially available habitats, particularly in the old bed of the Rhine, anadromous migratory fish are extremely rare in this section, as the ecological continuity of the Rhine has not yet been restored at the Strasbourg impoundment (inauguration of the fish passage planned for end 2015), at Gerstheim (construction planned for 2016-2017), Rhinau, Marckolsheim and in the Grand Canal d’Alsace.

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[41] ICPR report no. 228 (2015)

[42] ICPR report no. 208 (2013)

The return of the bitterling to the Rhine is encouraging. This species is above all continuously spreading in the northern Upper Rhine. Even the formerly rare spined loach is again regularly found in the Upper Rhine. With 64 % frequency of occurrence among individuals caught, the round goby here reaches its highest dominance. It is followed by roach, bighead goby, bleak and eel. All in all, 28 species have been detected in this section of the Rhine. Flow velocity increases in the water gap of the Middle Rhine, offering good conditions for rheophile species. All in all, 21 species have been recorded, but again half of the catches are round gobies. The species composition of the other species is similar to that of the northern Upper Rhine, even though the eel occurs a bit more often in the Middle Rhine, where it represents 5 % of the individuals caught. In the Lower Rhine, 27 species were detected. Here, too, almost half of the catches were round gobies. Apart from that, the bleak dominates with 20 %. The sub-dominant fraction consists of the species nase and perch. Together, the Delta Rhine and Lake IJssel have the highest density of individuals and species of all Rhine sections. Here, the ruffe is by far the most frequent species, followed by roach, bream, perch, monkey goby and smelt. All in all, 44 species were recorded in this section.

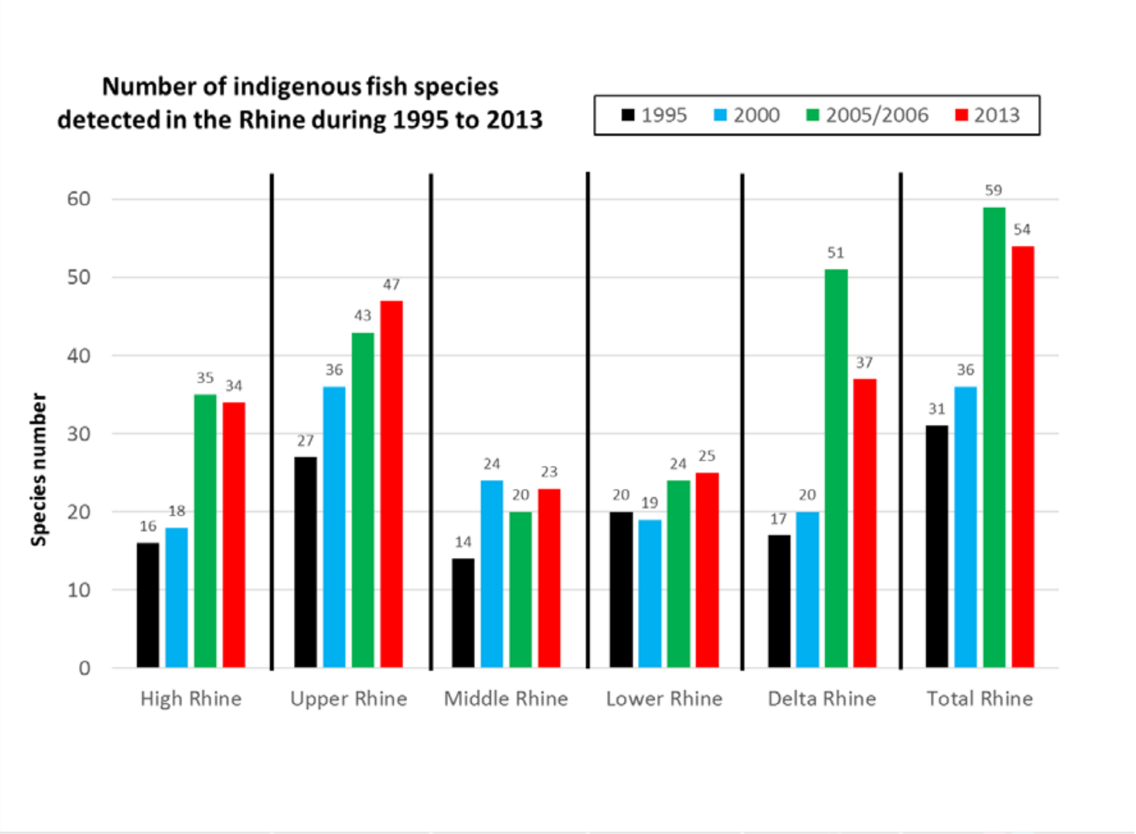
Generally speaking, the **fish density** has greatly diminished since the 1980s and is almost stable since 1993 (data from the Lower Rhine and from the fyke-net Moselle / Koblenz). This is presumably related to the improved water quality of the Rhine and its tributaries already before the WFD entered into force and to reduced organic substances, i.e. reduced food supply during 1984 to 1993. Often, the density of the fish stock in the Rhine itself varies considerably, even within one and the same year. Also, **dominance** varies considerably, in particular among very frequent fish species such as roach, bream, barbel and chub. All the same and compared to earlier surveys, considerable changes in dominance have been registered. This is a consequence of the spatial spreading and the increase in the stock of the alien gobies registered since the last stock-taking in the Rhine carried out by the ICPR in 2006/2007. At the ICPR sampling sites, on average, the round goby alone represented 28 % of the individuals; on the Upper Rhine, the relative frequency locally reached more than 90 %. Presumably, this will lead to crowding out indigenous species. As an example, the stock of the regularly detected ruffe is particularly declining at locations where riprap-structures predominate, which are ideal structures for goby species and offer good possibilities for high goby abundance. Furthermore, gobies represent a new food source for species predating fish such as pike-perch, barbel, catfish and bleak. In future, that might lead to considerable changes in the food web which, on the long run, may again lead to reduced goby stocks.

Figure 19: Left: Sea lamprey (*Petromyzon marinus*); right: Chub (*Squalius cephalus*). Photos: J. Schneider

As is shown in Figure 20, like in previous years, the species diversity in the Rhine is very high.

As a matter of principle it can be stated that the Rhine is a water body whose fish stocks have considerably changed during the past 20 years. Following the great improvement of its water quality, some species are today again settling or have spread in the Rhine. Additionally, many goby species from the Ponto-Caspian regions have immigrated and further increased the species number. However, the species number itself may not be considered as a criterion for an ecological improvement of the Rhine, as an increase in the species number may also indicate an interference, as is shown with the occurrence of alien goby species.

In addition, the increased number of detected species is also due to the better availability of data. More intensive investigations within WFD monitoring, the construction of further control stations at upstream fish migration passages at great hydro power plants, special investigations and new recording techniques contribute to the enhancement of knowledge on the Rhine fish fauna. This is very clearly shown by the comparison of the species numbers of the four ICPR survey campaigns between 1995 and 2013 (see Figure 20). The decrease of the species number in the Delta Rhine in 2013 is actually not a real decrease but a consequence of the ban on fishing eel following the high dioxin contents in 2011. As a consequence, the monitoring of by-catches in the fyke-nets of professional fishermen is lacking.



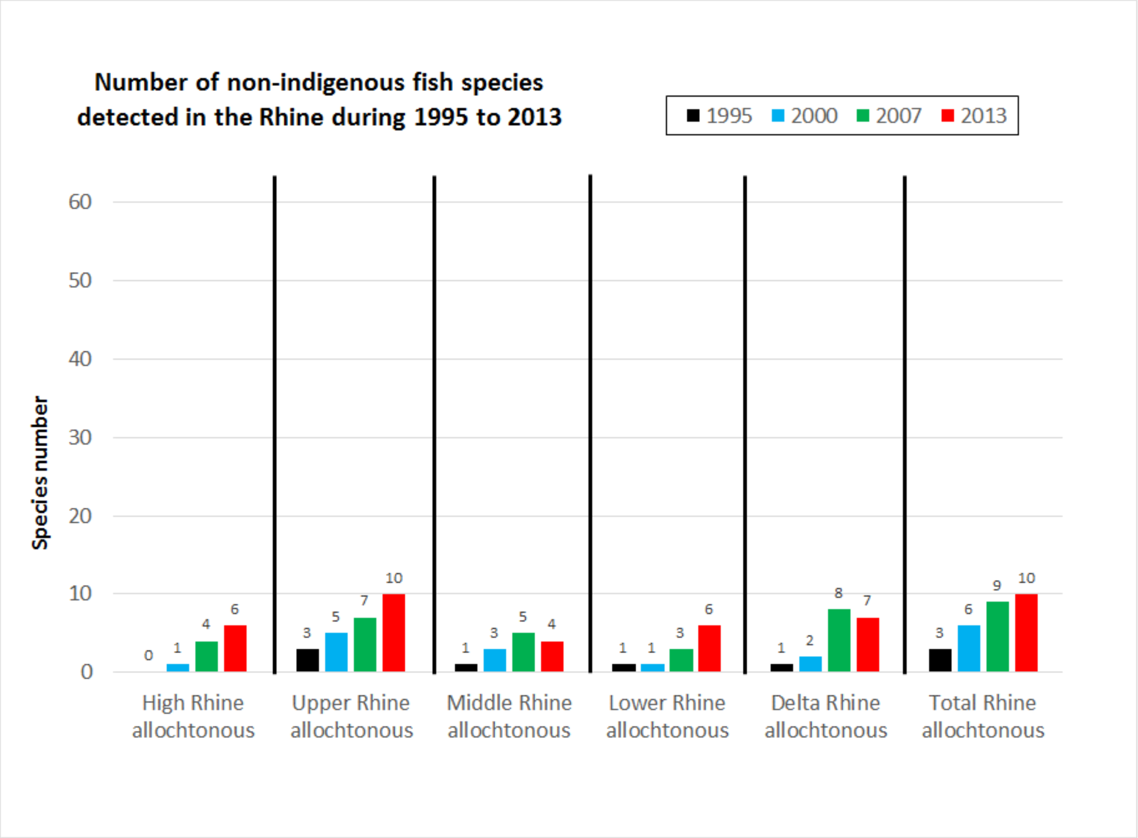


Figure 20: Number of indigenous (above) and non-indigenous (below) fish species detected in the Rhine during the four ICPR fish surveys in 1995 to 2013.

The national classification according to WFD resulted in a classification of the potential of the fish fauna in the Austrian Alpine Rhine as bad. The reason is above all the hydropeaking of hydropower plants and poor structures. From the point of view of fish ecology, the status of Lake Constance is good. The fish fauna of the impounded High Rhine between Lake Constance and the mouth of River Aare was classified to be moderate; no classification has as yet been possible beyond the mouth of River Aare. In the southern Upper Rhine, the fish fauna of the right bank was classified moderate and includes a poor section between Breisach and Strasbourg. On the left bank, these sections were classified as good. It has not been possible to achieve an agreement for this biological component, so that, on the map K 16, the river sections in question are “violet = varying classifications”. The potential of the northern Upper Rhine, the Middle Rhine and the Lower Rhine until the mouth of River Ruhr is moderate. Downstream the mouth of River Ruhr until and including the first water body in the Delta Rhine (Boven Rijn / Waal), the Rhine is classified as poor. Along with further water bodies, the Nederrijn / Lek, IJssel, Nieuwe Waterweg, Hollandse IJssel and Lake IJssel have been classified as moderate. With respect to the fish fauna, the Markermeer, Ketelmeer, Vossemeer and the Randmeren have been classified as good. The Dordtse Biesbosch has been classified as poor. According to the Directive, no evaluation of the fish fauna is required for the coastal waters and the Wadden Sea.

As a result of the improvement of the Rhine **water quality** during the past 20 years, the array of fish species is again almost complete and many invertebrate species characteristic for rivers which were considered to be extinct or strongly depleted, have again become an inherent part of the Rhine fauna. To some extent, this can also be demonstrated for aquatic macrophytes. However, certain fish species in the Rhine and its tributaries (e.g. eel) are still contaminated by **pollutants** (dioxins, furanes, dl-PCB, mercury, occasionally also indicator PCB, hexachlorobenzene = HCB or perfluoroctanesulphonate (PFOS)) among others from contaminated sites[43]. The contamination of biota (fish) with pollutants in the Rhine catchment has been recorded within a first joint coordinated analysis programme[44].

After shutting down nuclear power plants, the thermal pollution of the Rhine has already decreased during the past years (see Figure 9). Temperature values in excess of critical limits for the fish fauna, e.g. 25 °C which are expected to occur more often in future as well as their effects on the fish fauna, in particular on the target species of the migratory fish programme will be further observed. However, a considerable negative impact is rather unlikely, as maximum temperatures tend to occur during the summer months, i.e. outside the main fish reproduction period.

In order to establish and secure the stocks of migratory fish presently being built up or regenerating, the restoration of free migration in the Rhine (Haringvliet, impoundments in the southern Upper Rhine) and its tributaries is essential. Therefore, in particular in migratory fish waters, there should not be any further development of small hydro power plants.

In order to improve the habitats for the fish fauna in the Rhine, the main stream should be re-connected with the alluvial areas wherever possible, in order to open up side waters rich in aquatic plants, terraced scouring waters, impounded alluvial waters, alluvial zones with flow through and standing waters and by-passes as habitats (improvement of the lateral continuity). Parallel structures can create shallow replacement habitats and juvenile habitats protected against the lapping of waves in the river itself. Since the invasive gobies above all benefit from riverbank structures with riprap structures, the partial removal of riverbank stabilisations (e.g. at sloping banks) are an effective measure to counterbalance the further spreading of these species. In the tributaries, not only longitudinal river continuity, but also the lateral connection with the alluvial areas should be restored, in order to offer sufficient spawning and juvenile habitats to as many indigenous species as possible.

The ICPR “Master Plan Migratory Fish Rhine”[45] constitutes an important basis for planning measures. All of the measures indicated not only secure the positive development of fish stocks, but they equally contribute to an enhanced buffer capacity of the river system against an important increase in temperatures caused by climate change.

Migratory fish

Due to progress made with respect to the restoration of accessibility resp. the continuity of reproduction waters during the last 20 years, the situation of the stock of **long distance migratory fish** improved for a while: Increasing numbers of returners of **salmon** and **sea lamprey** and distinctly increasing numbers of proofs of reproduction in accessible water bodies gave evidence of the success of measures until 2007. However, between 2008 and 2013 registered proofs were lower for the great salmonids salmon and **sea trout**. The reasons discussed for the joint migration corridor Rhine and/or the coastal area are fishery (illegal catches), high predation pressure on smolts by predatory fish and cormorants, high smolt mortality rates in hydropower plants. Furthermore, reduced survival rates in the marine life cycle are assumed. In the upper sections of the Rhine, the construction of a 5th turbine at the Iffezheim impoundment between April 2009 and October 2013 led to a reduction of the number of upstream migrating individuals of numerous fish species. However, since the end of the construction works, the fish passage at the Iffezheim impoundment is again well used by the fishes. All 3 entrances are functioning and, in 2014, the recordings of salmon, sea trout, sea lamprey, barbel, nase and several other species are above those for the same species in former

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[43] ICPR report no. 195 (2011)
[44] ICPR report no. 216 (2014)
[45] ICPR report no. 179 (2009); ICPR report no. 206 (2013)

years (see Table 8, Figure 21). The recordings at the fish passage Gambsheim are correspondingly high.

At the time being, and due to the few specimen registered, it is not possible to state whether a comparable trend as that of big salmonids exists for the **river lamprey**.

After stocking measures in the Lower Rhine, the numbers of the formerly absent **houting** have distinctly increased and this species is again successfully reproducing in the lower sections of the Rhine and its delta. Stocking measures in the Rhine were stopped again as early as 2006 and since then, a self-sustaining population has established. Its stocks, as those of the **thwaite shad**, continue to be small.

The reduced number of detected **sea lamprey** also seems to be caused by the construction measures in Iffezheim between 2009 and 2013 and thus limited monitoring. Due to the past stocking measures in Hesse and North Rhine-Westphalia, the number of returning **allis shad** should distinctly increase in the years to come. Counts at the Iffezheim fish passage confirm this assumption. A large number of upstream migrating allis shad (157) was first documented at Iffezheim in 2014 (Figure 21); on 10 July 2013, the first allis shad was registered in the Moselle (Koblenz control station) for 60 years (Figure 22) and 1, resp. 2 and 4 allis shad were recorded in the Delta Rhine in 2012, resp. 2013 and 2014. In addition, the detection of individual young allis shad in the Upper Rhine in 2013 and 2014 upstream of all stocking sites seems to indicate a natural allis shad reproduction.
Table 8 and Figure 21 also indicate this positive development for the period January to September 2015.

Table 8: Results of fish counts at the Iffezheim impoundment since 2008 (*2015: January to September) Due to construction works to integrate a 5th turbine at the Iffezheim impoundment, the fish passage Iffezheim was partly not functioning between April 2009 and October 2013.

Fish species	**scientific name**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015***
Salmon	*Salmo salar*	86	52	18	50	22	4	87	209
Sea trout	*Salmo trutta trutta*	101	66	40	68	20	13	191	51
Sea lamprey	*Petromyzon marinus*	145	225	23	3	15	0	145	145
Allis shad	*Alosa alosa*	2	0	0	0	0	0	157	84
Eel	*Anguilla anguilla*	12,886	8,121	13,681	4,480	4,958	0	6,801	7,985
Nase	*Chondrostoma nasus*	720	426	370	830	451	313	9,380	18,150
Barbel	*Barbus barbus*	2,064	1,833	1,383	1,034	2,056	333	5,356	3,340
Bleak	*Alburnus alburnus*	726	352	182	145	137	0	20,350	7,199
Asp	*Aspius aspius*	2,122	1,590	1,329	773	673	5	3,658	5,932
Bream	*Abramis brama*	2,941	2,433	3,326	1,517	1,144	5	1,928	2,070
Other species		439	383	801	415	722	182	4,013	2,820
Total		**22,232**	**15,481**	**21,153**	**9,315**	**10,198**	**855**	**52,066**	**47,985**

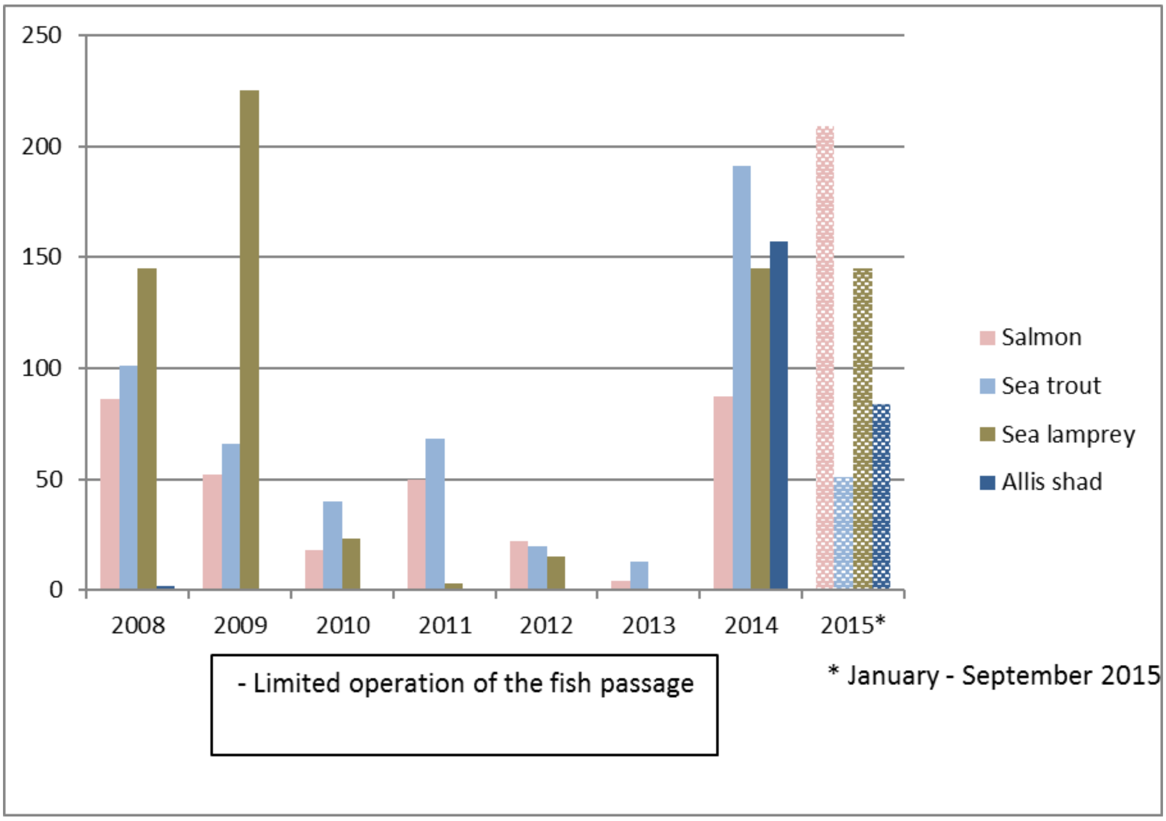

Figure 21: Results of fish counts of selected long distance migratory fish at the Iffezheim impoundment since 2008 (*2015: January to September)

Figure 22: First allis shad in the Moselle for 60 years. Photo: BfG

In the sub-basin **Alpine Rhine / Lake Constance** the Lake Constance lake trout (*Salmo trutta lacustris*) is the fish species migrating over the longest distances. In the Lake Constance region it is therefore also called “inland salmon”. Just as the salmon downstream of the Rhine Falls it has an important role for achieving the water protection targets. The Lake Constance lake trout grows up in Lake Constance until it is mature to spawn, subsequently it migrates into the tributaries to Lake Constance to spawn. This migration may stretch over 130 kilometres into the tributaries to the Alpine Rhine. Due to complex habitat requirements, self-sustaining lake trout populations are only able to settle in obstacle-free water systems with habitats for all stages of development permitting to conclude the entire life cycle of the species.

During the 1970s, the yield of the lake trout continuously sank in Lake Constance in spite of stocking measures (Figure 23). Looking back, the first lake trout programme of the “Lake Trout Working Group” was responsible for the survival of the lake trout in Lake Constance and that it may today again be used for commercial fishery. Saving the last spawning fish, the subsequent stocking measures and the gradual elimination of obstacles to migration in the spawning rivers figured among the decisive measures. In particular, the construction of the fish passage at the Reichenau (Switzerland) hydropower plant in 2000 represented an important step towards reopening historical spawning waters. In order to sustainably secure the stock of fish, they must again have the possibility to develop self-sustaining populations. The long-term target is to reduce the present intensive stocking measures or to even be able to completely stop them.

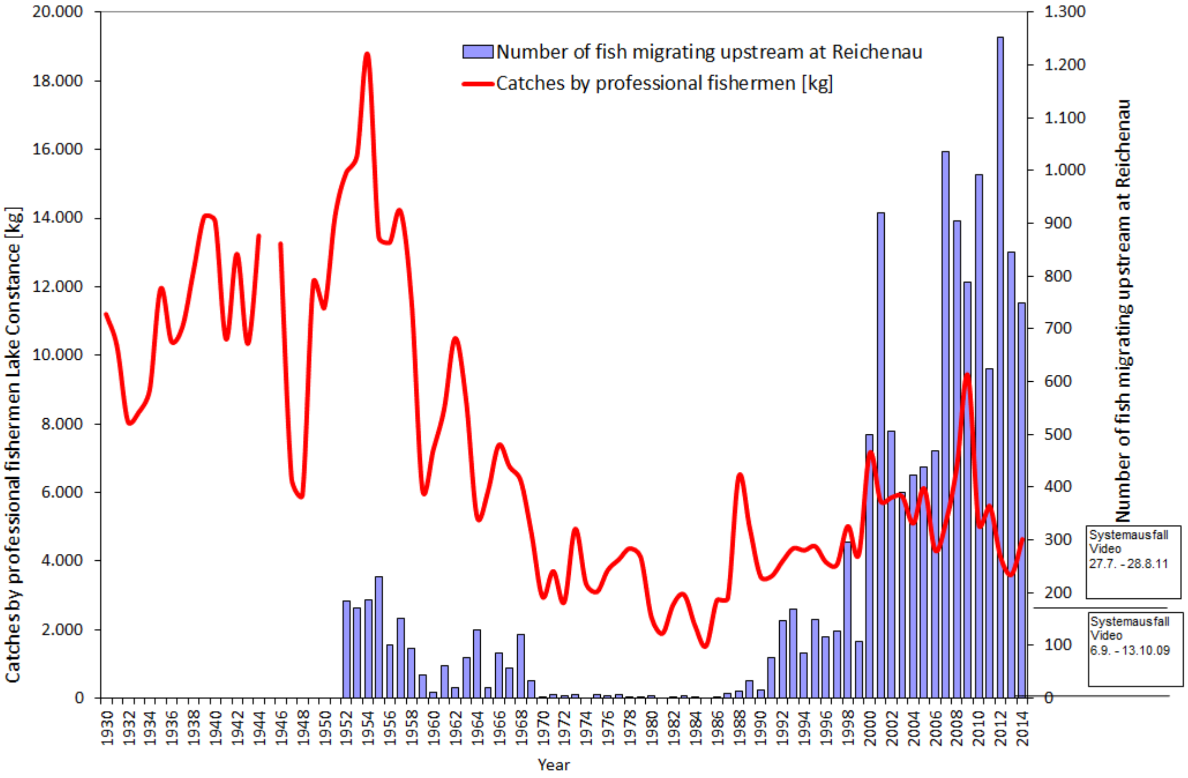

Figure 23: Lake Constance lake trout catches by professional fishermen in Lake Constance-Obersee and number of fish migrating upstream at the Reichenau power plant (Switzerland): Caught broodstock (until 1999), fyke-net control (as of 2000) and video counting (as of 2007).

During the past decades, the stocks of the **European eel** have greatly diminished in almost its entire distribution area, including the Rhine and its tributaries. Since the beginning of the 1980s, only a few percent of the long-time average numbers of glass eel migrating upstream into the rivers return. Among the known causes figure habitat modifications, parasite infections, the construction of hydropower plants for energy production, overfishing of the stock of glass eel and silver eel and sediment pollution. Since 2010 (except for 2012), the numbers of glass eel on the Dutch coast again show a slight trend towards improvement, even though the numbers remain at a low level (Den Oever index for the period between March and May: 2013: 4.4 %; 2014: 6.4 % of the long-standing average).[46]

In almost all water bodies where eel occur in the Rhine catchment its migration is impeded by transverse structures. This particularly applies to the Delta Rhine, the southern Upper Rhine and almost all Rhine tributaries. In particular, downstream migrating eels are at risk: Often, they get into the turbines of hydropower plants. Due to the length of their bodies they may suffer from grievous, mostly lethal injuries; the cumulated mortality may be considered substantial if several transverse constructions follow one another.

The **European sturgeon** (*Acipenser sturio*) died out in the Rhine catchment in the 1940/1950s and ranges among the worldwide most endangered species. Since 2012, some specimen are again being stocked into the Delta Rhine within a species protection programme.

Map K 16 presents the current national classification of the fish fauna in the IRBD Rhine (basic network of water bodies, catchment area > 2,500 km²) according to the WFD.

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[46] IMARES (2014): Glasaalonderzoek Den Oever

Physico-chemical elements and substances relevant for the Rhine supporting the classification of the ecological status/potential

The general **physico-chemical quality elements** such as the nutrients nitrogen and phosphorus and the substances defined as relevant for the Rhine river basin district[47] are part of the classification of the **ecological status / potential.** Annex V of the WFD requires a classification of these quality elements together with the biological quality elements.

The selection of these substances is based on the environmental relevance of each of the substances and on the number of monitoring stations, where these substances were measured in previous years and in what concentrations. The lists of Rhine substances are updated every 3 years. The next update of the list of Rhine substances is due for 2017.

For 13 of the 15 substances relevant for the Rhine, environmental quality standards (EQS Rhine) have been derived (see Annex 3). At present, an EQS Rhine is being developed for copper, but will only be effective for the classification under the third WFD cycle.

The classification of substance concentrations determined in the Rhine is based on a comparison of measured annual average values with the individual national determination taking into account the Rhine, as well as other river basins and may thus differ from the EQS Rhine.

Based on national classification criteria, Annex 2 gives the results for the physico-chemical elements and for the 15 substances relevant for the Rhine at 56 monitoring stations:

- At some monitoring stations, the values are in excess of the (national) EQS for copper, zinc and PCB (annual average);
- At few, resp. only one monitoring station, arsenic (in suspended matter in River Kinzig/Main and Erft), chromium (Wadden Sea coast), ammonium-N (Emscher, Vechte), dichlorvos (Erft) and dimethoate (River Schwarzbach/Main) exceed these EQS;
- National norms for arsenic (water phase), bentazone, 4-chloroanilin, chlorotoluene, dichlorprop, MCPA, mecoprop and dibutyltin compounds are respected at all monitoring stations.

The values of the metals copper and zinc in the water phase at some Dutch monitoring stations are in excess of the EQS. For these metals (in 8 cases for zinc, in 5 cases for copper) values in excess of national standards are measured in suspended matter in the Moselle at Palzem, in the Schwarzbach (Main), the rivers Lahn, Sieg, Wupper, Erft, Emscher and Lippe.

For the group of **PCBs**, there are measures in excess of national standards in the Dutch Rhine delta, in one coastal water body and three tributaries to the Rhine in Germany (Schwarzbach (Main), Wupper, Emscher). These exceeding values are stated in suspended matter, in particular in higher chlorinated PCBs.

As is shown in Annex 2, analysis data permitting a check of the EQS for **dichlorvos** are only available for some of the monitoring stations. Often, the analysis procedure was not sufficiently sensitive. Thus, at one monitoring station, exceeding values were determined. With the Directive 2013/39/EU entering into force, dichlorvos will belong to the priority substances.

Apart from known substances, “new” substances may be determined as relevant for the Rhine following innovations in industry, altered uses by consumers, new environmental analysis possibilities or increasing knowledge concerning the eco-toxicological effects of substances. For other substances, concentrations might drop as a result of reduction

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[47] ICPR report no. 161 (2007); ICPR report no. 189 (2011)

measures so that these substances are no longer relevant for the Rhine. Therefore, the lists of substances are updated.

The Rhine monitoring programme going on since 1st January 2015 is based on the list of Rhine substances 2014[48]. Naturally, no exhaustive data are available for new substances included (due to their relevance for drinking water), such as acesulfam and 1.4-dioxan.

The evaluation of annual mean values does not show, whether the pollution of the Rhine with other substances getting into the waters accidentally or within targeted intermittent emissions originate from ships, for example, or from irregular agricultural practice. In order to record such discharges, the Rhine is continuously being monitored. Pollution events recorded in this context are described in the annual WAP compendium of the ICPR. The corresponding **warnings and alarms** are investigated by the water police or within water management measures.

Also, the analysis of data of the surveillance monitoring stations do not show pollution events leading to an excess of the environmental quality standards in smaller waters in the catchment. Further information is found in the B parts.

Since the 1950s, the **physico-chemical elements** in the main stream of the Rhine are under intensive, internationally coordinated surveillance.

Development since 2009

Nitrogen concentrations of the Rhine at the German-Dutch border Bimmen/Lobith, that is, before the ramification of the different arms of the Rhine, have continued to fall during the past years (Table 9). The target value of 2.8 mg/l total nitrogen was reached in 2012 and slightly exceeded in 2013.

This result corresponds to the fact that the phytoplankton in the Dutch coastal waters has achieved a good status, even though the concentrations still exceed the guidance value for inorganic nitrogen dissolved in water (DIN guidance value). However, this good status is not as stable on the Wadden coast and in the Wadden Sea as along the Dutch coast. In the eastern part of the Wadden Sea the status is worse than in the western part.

Table 9: Nitrogen concentrations (values in summer and average annual value and standard in mg total N/l) at Lobith, Maassluis, Kampen and Vrouwezand

Year	Lobith		Maassluis*		Kampen		Vrouwezand	
	Summer	Year	Summer	Year	Summer	Year	Summer	Year
Standard	***2.5***	***2.8***	***2.5***	***2.8***	***2.5***	***2.8***	***1***	***-***
1985	5.3	6.5	5.1	5.6	5.5	6.4	4.2	4.1
1990	5.0	5.6	4.2	4.8	5.0	5.8	3.5	4.0
1995	3.6	4.3	3.8	4.3	3.6	4.8	3.0	3.6
2000	3.1	3.3	2.9	3.3	3.4	3.9	3.0	3.2
2005	2.6	3.4	2.5	3.0	2.7	3.6	2.1	2.5
2010	2.3	2.9	2.3	3.0	2.6	3.1	2.5	2.7
2011	2.6	3.0	2.2	2.7	2.5	3.1	2.5	2.7
2012	2.3	2.8	2.1	2.6	2.3	2.8	2.2	2.3
2013	2.6	2.9	2.4	2.7	2.6	3.0	2.2	2.6

* Maassluis is located at a transitional water body. Therefore, the standard should normally be converted into 0.46 mg DIN/l at salinity 30.

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[48] ICPR report no. 215 (2014)

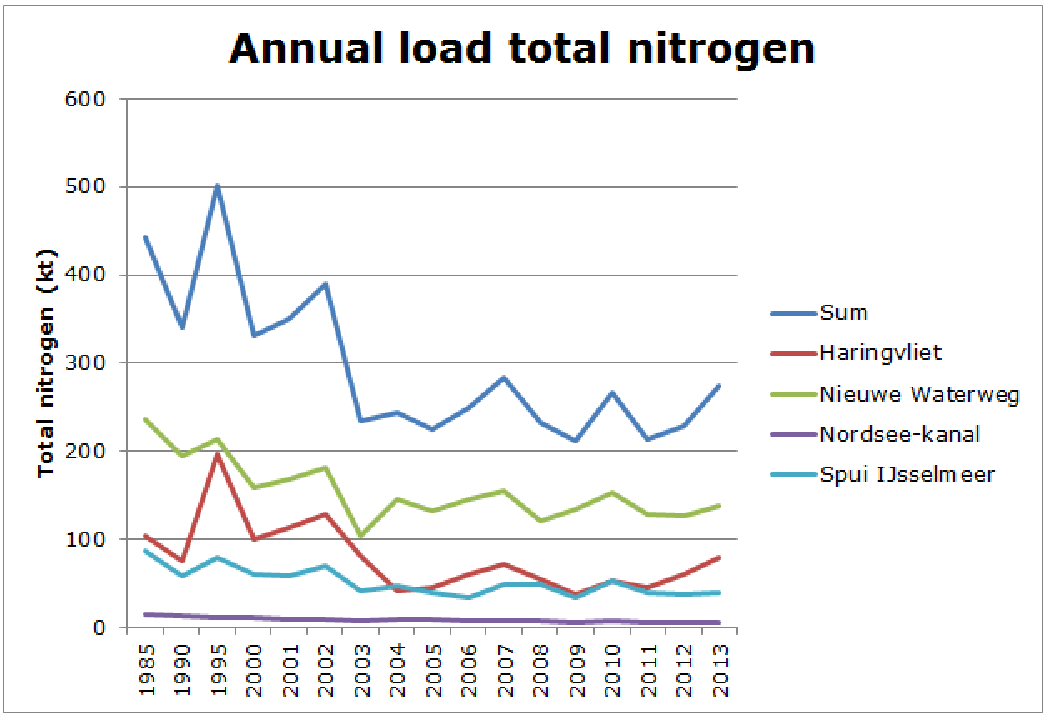

Figure 24: Annual total nitrogen load (in kT) discharged into the estuary of the Rhine, the coastal waters and the Wadden Sea during 1985-2013.

Dutch coastal waters are considerably – but not only – impacted by the runoff from the Rhine on its way to the coast via the Nieuwe Waterweg and the Haringvliet. There is a direct correlation between the river load in the delta and concentrations in the coastal area. Estimates indicate that the runoff of Rhine and Maas all in all carries 77 % of the total nitrogen load of the coastal area within the 1-nautical mile coastal zone, about 13 % originate from the Channel, 6 % from the Belgian Scheldt, 2 % from France and 1 % each from Great Britain and Germany[49].

Development since 2009

The average annual load of total nitrogen (in kT) calculated on the basis of immission data discharged into the estuary of the Rhine, the coastal waters and the Wadden Sea has been reduced from 273 kT during 2000-2006 to 232 kT during 2007-2013.

Nitrogen inputs for 2014 are indicated with about 292 kT (see Table 12 in Chapter 7) and remain in the same order of magnitude as for the Management Plan 2009.

During the second management period until 2021, the influence of the nitrogen inputs of the Rhine on the water bodies of the eastern Wadden Sea will be checked.

At the other surveillance monitoring stations, exceeding total nitrogen values are registered at Maassluis, in River Vechte, in the Wadden Sea and on the Dutch coast as well as in Lake IJssel (see Annex 2).

Since nitrogen concentrations are expected to be further reduced, concentrations and loads will continue to fall. In spite of this development, nitrogen continues to be a relevant substance with a negative impact on the status, as in some surface waters (see Annex 2) as well as in groundwater (s. Map 25) concentrations are too high. If all water bodies are to achieve or maintain a stable, good status, efforts towards reducing nitrogen must be continued.

At many of the 56 monitoring stations of the Rhine Monitoring Programme, the national classification standards for **total phosphorus** or **ortho-phosphate-phosphorus** are

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[49] Blauw et al. 2006

exceeded. At the following monitoring stations, no exceeding values were determined: Öhningen, Weil am Rhein, Karlsruhe / Lauterbourg, Worms, Mainz, Düsseldorf, Lobith, Kampen / IJssel, Vrouwezand (IJsselmeer), Sieg, Wupper and Ruhr.

The **temperature** is a critical parameter for plants and animals in water bodies. High temperatures in summer (≥ 25 °C water temperature) may be a stress factor for migratory fish, may imply an increased risk of infections and a temporary interruption of upstream migration[50].

The national assessment standards for temperature are exceeded in the Rhine at Öhningen and Weil am Rhein, in the Schwarzbach (Main), in the Main at Bischofsheim as well as in the rivers Wupper and Erft.

Along eleven monitoring stations in tributaries, the assessment standards for dissolved **oxygen** or oxygen saturation are not respected. At two monitoring stations in the Rhine, fifteen monitoring stations along tributaries and in Lake IJssel, the annual average **pH-value** is outside the recommended range of values.

Exceeding **chloride** values are registered at the Palzem monitoring station on the Moselle, in the mouth of River Lippe at Wesel and in the mouth of River Emscher.

In Lake Constance, the national EQS and recommendations are respected at the surveillance monitoring station.

Total assessment of the ecological status / potential

Since the beginning of the 1990s, and due to today's good Rhine water quality, and the already implemented measures targeted at improving river continuity and at enhancing structural variety, the biocoenoses of the Rhine have distinctly recovered: Among the invertebrates, many original Rhine species have returned; with respect to the fish fauna, the range of species is almost complete, even though this statement does not apply to all sections and original population densities. In some areas, the stocks of aquatic plants typical for the river and its alluvial areas have well developed.

In parallel to this trend, increased immigration of non-indigenous (alien) species through navigation channels leads to an overriding biological modification which above all concerns invertebrates, since 2006 however also fish species. The main immigration corridor is the Main-Danube-Canal, by which small crustaceans, but also the first goby species have arrived. Due to different non-indigenous species, the biocoenosis of the Rhine is again and again distinctly changing and dominance proportions vary. These changes also leave their marks in the present classification of the ecological status/potential.

Annex 1 lists the results at the monitoring stations of the "biology" surveillance monitoring for the IRBD Rhine, that is, the assessment of the individual quality elements and the summary assessment for the substances relevant for the Rhine and the physico-chemical elements (see individual results for the 56 surveillance monitoring stations for chemistry in Annex 2) supporting the ecological assessment.

The most recent national classification of the ecological status / the ecological potential for all water bodies in the IRBD Rhine according to the WFD (basic network of water bodies, catchment area > 2,500 km²) is shown in Map K 17. As far as this is decisive for not achieving the good status / potential, this map shows a black dot in the middle of water bodies with values exceeding one or more EQS (substances relevant for the Rhine).

Further information is available in the corresponding parts of the B-reports.

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[50] ICPR report no. 167 (2009)

4.1.2 Chemical status

The chemical status of a surface water body is classified according to the concentrations measured for priority substances and priority hazardous substances. The list of substances corresponds to the EQS Directive 2008/105/EC in the version of the Directive 2013/39/EU.

The basis for the monitoring programme assessed in this report is the list of substances determined in the EQS-Directive. In the meantime, the EQS Directive has been updated by the Directive 2013/39/EU to be implemented in national law by 14 September 2015. The EQS have been revised for seven substances which had already been treated. These revised EQS are to be applied as of 22 December 2015 in order to achieve the more demanding objectives within the new programmes of measures of the second Management Plan by 22 December 2021.

Data can only be analysed for substances listed in the EQS Directive 2008/105/EC and which have thus been comprehensively included into the monitoring programmes. The classification of the substance concentrations measured in the IRBD Rhine is done according to the specifications of the Directive 2013/39/EU.

Annex 5, the Maps no. 19 and 20 and Figure 25 include the classifications of the average annual value based on classification standards valid in the entire EU.

As they continue to occur in unchanged, high concentrations in almost all water bodies in Europe, the ubiquitous substances / groups of substances PBDE, mercury, PAH and TBT lead to a chemical status “failing to achieve good” almost everywhere in Europe, thus also in the Rhine catchment.

As far as the ubiquitous substances mercury and the PAH compounds, in particular benzo(g,h,k)perlylen and indeno(1,2,3-cd)pyren are concerned, Annex 5 and Map K 19 show values in excess of the EQS at almost all monitoring stations resp. for almost all water bodies in the Rhine catchment.

Further substances classified as ubiquitous at EU level, **PBDE** and **tributyltin** certainly exceed the environmental quality standards at certain monitoring stations, but for most of the other monitoring stations, no classified results are available as yet.

The PAH compound **fluoranthene** which is not classified as ubiquitous exceeds the EQS at a great number of monitoring stations. The other substances not classified as ubiquitous are less exceeding the EQS. According to Annex 5, **nickel** (Lobith, Kampen) and **hexachlorobenzene** (Weschnitz, Schwarzbach / Main, Nidda) exceed the EQS at 2 resp. 3 monitoring stations. Furthermore, the impounded Upper Rhine has a section in which hexachlorobenzene is in excess of the EQS which is not shown in the monitoring stations Weil (upstream the impounded section) and Karlsruhe (downstream the impounded section) in Annex 5. For further information please refer to the B-reports. **Hexachlorobutadien** (Lippe) and **bis(ethylhexyl)phtalat** (Wadden Sea coast) exceed the EQS at one monitoring station each.

At the time being, further priority substances, such as lead, cadmium and isoproturon do not exceed the annual mean EQS (Annex 5). Nevertheless, they are analysed in detail as, in the past, they exceeded the target values and the EQS[51]. In addition, pollutant waves of isoproturon are measured during periods of application in agriculture. These do not lead to annual mean values exceeding the EQS, but the maximum values are in excess of the quality standards determined. Also, during the past years, there have been several reports of increased isoproturon concentrations within the Warning and Alarm Plan Rhine which led to stopping or restricting the intake of Rhine water for drinking water production purposes.

Map K 19 is summarised in Figure 25 (left). Figure 25 shows the classification of the chemical status based on the number of water bodies for all water bodies at level A

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[51] ICPR report no. 215 (2014)

(above) and for the main stream of the Rhine (below). Accordingly, at the time being, 4 % of all surface water bodies and 2 water bodies in the main stream of the Rhine are classified as good. 95 % of all surface water bodies and 93 % in the main stream of the Rhine have been classified as failing to achieve good.

Due to the extensive occurrence of one or more ubiquitous substances, a differentiated analysis of the pollution with the rest of the substances is required. Therefore, the Directive 2013/39/EU gives the possibility to additionally present the chemical status **without the ubiquitous substances**. These presentations are given in Annex 5, Map 20 and Figure 25 (right).

Figure 25 (right) and Map 20 illustrate that, in the Rhine catchment, one or more non-ubiquitous priority substances in smaller water bodies exceed the EQS. In about two thirds of the surface water bodies in the IRBD Rhine (graph above right) and in more than one third of the water bodies of the main stream (graph below right) the EQS of "non ubiquitous substances" are not exceeded. For differentiated representations, please refer to the Part B reports.

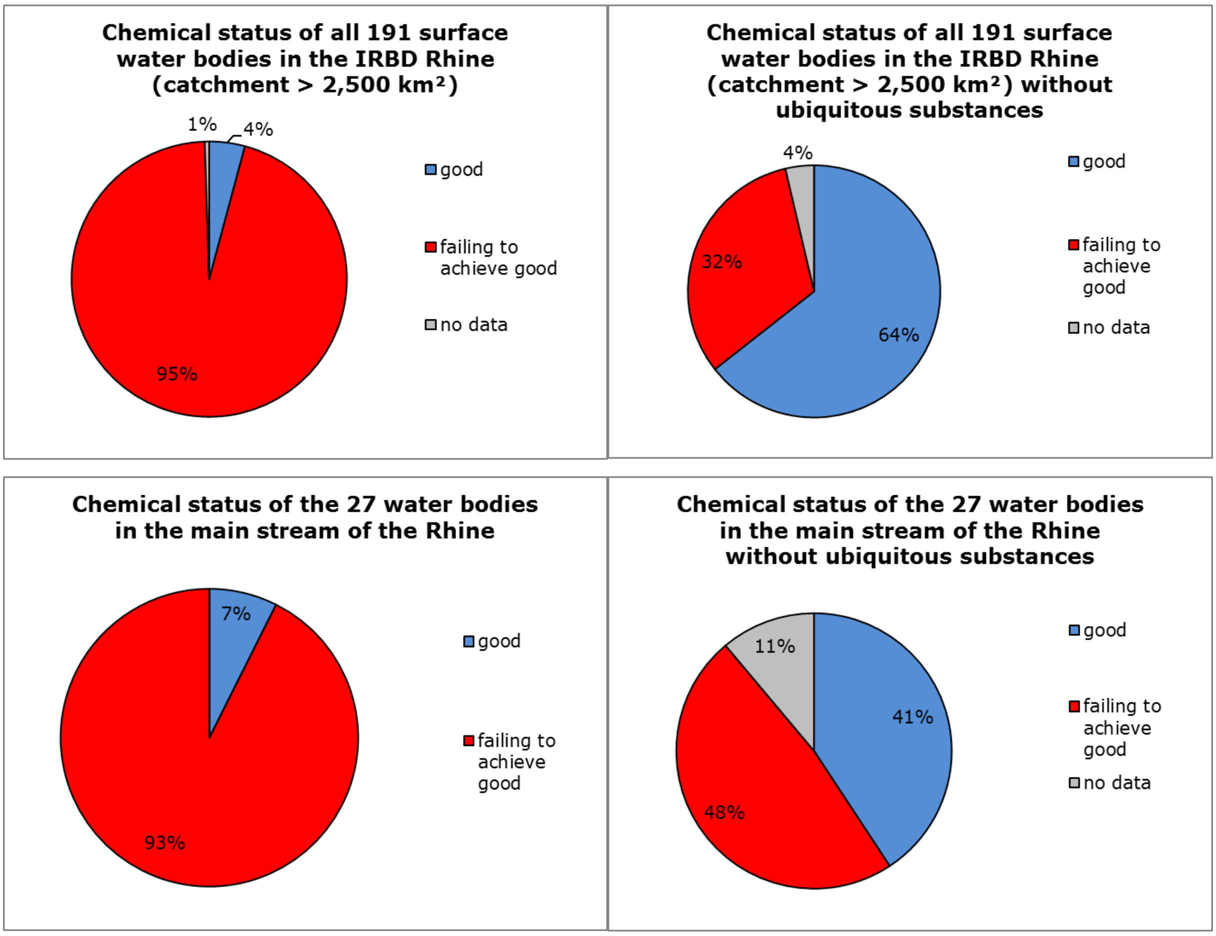

Figure 25: Present chemical state (classification results 2012/2013) of all surface water bodies in the IRBD Rhine (catchment > 2,500 km², above) and of the water bodies in the Rhine catchment (below) with (left) and without (right) ubiquitous substances. Up-to-date national classification according to Directive 2013/39/EU. State: December 2015; data without Switzerland, see text for Figure 10

So far, for the **13 new substances of the Directive 2013/39/EU** for which EQS have been determined (10 pesticides: aclonifen, bifenox, heptachlorine and heptachlor epoxide, dicofol, quinoxyfen, cybutryn, terbutryn, dichlorvos, cypermethrin; other substances: dioxins, hexabromocyclododecane, perfluoroctanesulphonate; see Annex 4) there are no (sufficient) data on the classification of the status of water bodies at all ICPR surveillance monitoring stations. The new identified priority substances and their environmental quality standards will be taken into account when drafting additional surveillance programmes and programmes of measures to be presented by the end of December 2018.

4.2 Groundwater

According to WFD guidance, groundwater (its chemical and quantitative status) must basically achieve a “good quantitative status” and a “good chemical status” by the end of 2015.

Groundwater has at least been controlled according to WFD since 2007, normally in the upper main aquifer, in some federal states also in the lower main aquifer on the level of delimited groundwater bodies or groups of groundwater bodies.

As a matter of principle, surveillance monitoring of the chemical status is done in all groundwater bodies and serves to determine and monitor the status and the trend of pollutant concentrations resp. to identify a trend reversal. Operative surveillance is only done for those groundwater bodies which, according to the survey and / or surveillance monitoring were classified as “achievement of target unlikely” or “achievement of target uncertain” and serves to determine the status of these groundwater bodies, their trend and the development of the effects of measures taken to achieve the target.

The monitoring networks for the surveillance of the quantitative (Map K 21) and chemical status of groundwater bodies (Map K 23) were established on schedule by 22 December 2006.

Guidance on the classification of the chemical groundwater status is given above all in the WFD daughter directive groundwater (2006/118/EC) as well as in the “Guidance Document: Groundwater Status and Trend Assessment EC 2009“. The modification of Annex II of the Directive 2006/118/EC by the Directive 2014/80/EU of 20 June 2014 has to be implemented in national law within 2 years and will thus only take effect for the 3rd Management Plan.

Quantitative status

According to WFD Annex V, the quantitative status of groundwater is good if there is no excessive use of groundwater and no significant interference with terrestrial ecosystems or connected surface water bodies. Furthermore, there should be no signs of intrusion of salt and other substances.

The yardstick for the quantitative status of groundwater is primarily the groundwater level or the pressure height of groundwater in cases of non-confined aquifers. Furthermore, discharges from springs are considered. The analysis of groundwater levels is e.g. carried out with the help of trend calculations based on long-time groundwater level hydrographs.

If the groundwater level cannot be monitored, e.g. in solid rocks or if the number of suitable monitoring stations is insufficient, supplementary or alternative water balances will be established in order to determine the groundwater status.

Another criterion used for the assessment of the quantitative groundwater status is the impairment of terrestrial ecosystems depending on groundwater. For the survey, those terrestrial ecosystems depending on groundwater were chosen for which a risk of impairment exists. If required, the groundwater level will be monitored in these areas.

Chemical status

According to the WFD and the groundwater daughter directive (Directive 2006/118/EC), the groundwater chemical status is good when EU quality standards are adhered to (nitrate[52] 50 mg/l, pesticides 0.5 µg/l and individual pesticides 0.1µg/l) and there is no impairment of terrestrial ecosystems dependent on groundwater or connected surface waters. Furthermore, there shall be no signs of intrusion of salt and other substances of anthropogenic origin. According to the groundwater daughter directive, a groundwater body has a good chemical status, if - besides other criteria - the above-mentioned quality standards and national threshold values (see Annex 6: groundwater threshold values determined at a national level) are respected at all monitoring stations.

If the quality standard or threshold value is exceeded at one or more monitoring stations, the groundwater status is good if the excess values are not significant for the groundwater body. The daughter directive does not give any precise information concerning the assessment of significance. The “Guidance Document Groundwater Status and Trend Assessment EC 2009” indicates how the assessment of significance can be carried out:

This assessment includes different tests to determine whether values in excess may lead to not achieving the good chemical status. These tests take into account environmental criteria and criteria of use. All in all, the classification procedure for the chemical groundwater status includes 5 different tests:

Test 1: General quality classification (total surface resp. total volume of the groundwater body in which exceeding values have been determined amounts to less than 20 % compared to the entire groundwater body);

Test 2: Salt or other intrusions;

Test 3: Surface water bodies;

Test 4: Terrestrial ecosystems depending on groundwater;

Test 5: Drinking water protection areas according to WFD, Article 7.

Another significant element of surveillance monitoring is the determination of trends in cases of significantly increasing pollutant concentrations. The starting point for trend reversal is defined as 75 % of the quality standard or of the threshold value. Measures may be required for a groundwater body with good status if a significantly increasing pollutant trend is registered. When the starting point for trend reversal is achieved, measures must be taken.

With a view to assessing the effects of relevant point sources, additional trends must be determined for certain pollutants and it must be ensured that pollutant plumes will not spread and deteriorate the chemical status.

4.2.1 Quantitative groundwater status

On the whole, and just as in the Management Plan 2009, the quantitative groundwater status in the Rhine catchment can be characterised as good (Figure 26). Map K 22 shows that, compared to the Management Plan 2009, largely the same groundwater bodies (4 %) are in a poor quantitative status.

There are individual cases of extensive drops in the groundwater level, e.g. due to coal mining and which are of regional importance. In this connection, the open-cast lignite mines on the left banks of the Lower Rhine are to be mentioned. Further reasons for a poor quantitative status are impacts on groundwater dependent land ecosystems resulting from a lowering of the river bottom of the Rhine and effects of climate change.

Even though, in the Netherlands, almost all groundwater bodies have a good quantitative status, the drying up of terrestrial ecosystems is a problem in many places.

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[52] According to nitrates directive + daughter directive groundwater

The poor quantitative status of the two groundwater bodies in Rhineland-Palatinate has not been improved by 2015, as no reduction of groundwater abstraction has so far been implemented. Due to the hydrogeological situation of the region it proves to be difficult to develop substituting sources.

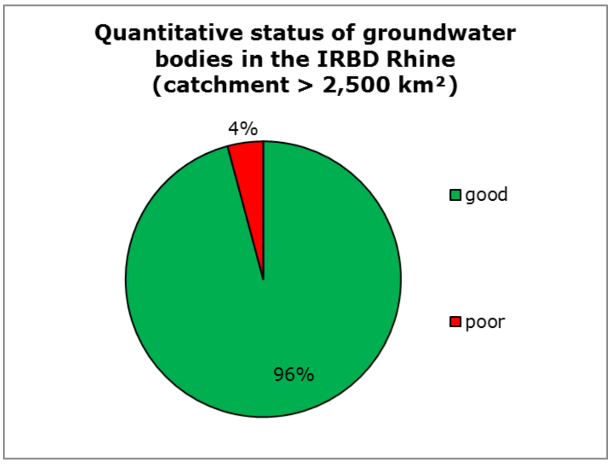

Figure 26: Present quantitative status of groundwater bodies in the IRBD Rhine (catchment > 2,500 km²). State: December 2015; data without Switzerland, see text for Figure 10

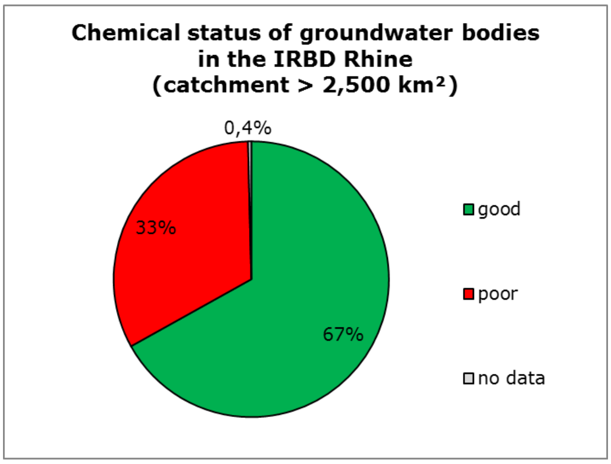

Figure 27: Present chemical status of groundwater bodies in the IRBD Rhine (catchment > 2,500 km²). State: December 2015; data without Switzerland, see text for Figure 10

4.2.2 Chemical groundwater status

The result of the classification of the chemical groundwater status in Figure 27 and Map K 24 (total classification) and in Map K 25 (nitrate) shows a comparable situation as that of the Management Plan 2009. All over the Rhine catchment, the chemical status of several groundwater bodies was classified as poor (33 %). However, the chemical status of most groundwater bodies (67 %) is good.

In Map K 24 of the overall classification, groundwater bodies with significantly increasing pollutant trends are highlighted by a black dot. Due to insufficient long-term data sets, some states or federal states have not indicated any trend while, in individual cases, even a trend reversal is being reported.

In the Rhine catchment area, too high nitrogen inputs (nitrate and ammonium) of the upper main aquifer continue to be the most important problem. Therefore, a separate map has been established for the contamination of groundwater with nitrates (Map K 25). It is only slightly different from the map showing the overall pollution, as most of the groundwater bodies have a poor chemical status due to the nitrate pollution. The causes are, above all, fertilisation in agriculture and intensive livestock farming.

Furthermore, inputs of pesticides (and their degradation products / metabolic products) lead to a poor chemical status of certain groundwater bodies. Also, due to national threshold values for plant protection agents (Annex 6), the chemical status of certain groundwater bodies is poor, which is caused by these substances. This is true of the national threshold values for ammonium, heavy metals and salts, volatile chlorinated hydrocarbons and fluorosurfactants (PFT). Some groundwater bodies also fail to achieve the good chemical status due to:

- pollution from mining activities
- historical contamination
- difficulties for drinking water production
- effects on surface waters or
- effects on land ecosystems depending on groundwater.

In 2015 and compared to the Management Plan 2009, the chemical status of groundwater bodies in the Rhine catchment has hardly changed. The main contamination of groundwater bodies presenting a poor status is due to nitrate, to a lesser extent due to plant protection agents. In spite of measures taken, the contamination of groundwater with nitrate has not been reduced appreciably, which is due to the unfavourable hydrogeological and climatic conditions (karst and crevice aquifers and often not very thick surface layers and little precipitation). Presumably, measures taken, such as increased advice to farmers and measures in agriculture to reduce nitrate leaching into groundwater will only show the desired effect after several years.

In the German federal state Baden-Württemberg, the chemical status of groundwater bodies in the Rhine catchment has slightly improved. With respect to nitrate, eight out of 18 groundwater bodies at risk were classified as “good status” in 2015. Nevertheless, existing measures will be carried on also in these cases in order to secure the status achieved. Apart from nitrate, the chloride pollution originating from potash mining at Fessenheim is responsible for the classification of a further groundwater body as poor.

The chemical status of groundwater bodies in the parts of the German Rhine catchment located in Bavaria, Rhineland-Palatinate and Hesse in 2015 has hardly changed as compared to the Management Plan 2009. The main contamination of groundwater bodies presenting a poor status is due to nitrate, to a lesser extent due to plant protection agents. So far, measures taken do not show any measurable modification of groundwater quality. This is e.g. due to the residence times of seeping water and groundwater.

In the French Moselle catchment area, the number of groundwater bodies presenting a poor chemical status has increased.

In the North Rhine-Westphalian part of the German Rhine catchment, the number of groundwater bodies presenting a poor chemical status has increased. Today, about 50 % of the land surface of North Rhine-Westphalia are polluted by nitrate (about 40 %) or other substances (about 38 %) or point sources or significant impacts on protected goods to such an extent that groundwater bodies concerned must be classified as poor. Above all, nitrate contamination has distinctly increased in some groundwater bodies. However, partly, the worse classification is exclusively due to modifications of the classification procedures, while monitoring values and/or contaminations have not changed.

In Luxemburg, 3 out of 6 groundwater bodies present a poor chemical status, which is due to pesticide metabolic products from diffuse sources in agriculture (3 groundwater bodies) and nitrate (1 groundwater body). The development compared to 2009 is due to the fact that the classification method according to the “Guidance Document Groundwater Status and Trend Assessment EC 2009” was used. In spite of measures taken aimed at groundwater bodies, no significant reduction of the contamination has been recorded.

In the Netherlands, the general chemical status of almost all (11) groundwater bodies achieves the objectives for substances for which European standards have been set as well as the threshold values agreed upon at a national level. The groundwater body

Dune Rhine-West along the coast of North and South Holland until Texel is an exception to this. In this groundwater body, the concentration of total phosphorus is exceeded at more than 20 % of the monitoring stations. Furthermore, there are problems at some water intakes and in some nature reserves, the good status is not achieved.

The water body Sand Rhine-East presents an increasing trend for arsenic in the deep groundwater aquifer. In the tidal flat Rhine-North, the upper and lower groundwater aquifer presents an increasing trend for chlorides. In Salt Rhine-North, phosphorus is increasing in the upper groundwater aquifer. The trend analysis is based on two monitoring years. Nothing indicates that these negative trends are caused by human activities. New monitoring campaigns will result in additional information on this point.

Compared to 2009, the chemical status of Dune Rhine-West was classified as poor. This is a result of lowering the threshold value for phosphorus from 6 to 2 mg/l. Concentrations do not show any negative trend, thus, the situation has not worsened.

5. Environmental objectives and adjustments[53]

Basically, WFD Article 4 determines the environmental objectives to be achieved for each class of water body (natural water bodies, NWB; artificial water bodies, AWB; heavily modified water bodies, HMWB). These objectives are summarised in Table 10. If it proves to be impossible to achieve the objectives by 2015, deadlines may be extended to 2021 or 2027 or other dates and relevant reasons must be submitted.

Table 10: Environmental objectives for water bodies according to WFD

Category: Water body		**Overriding objective**			
			Good status / good potential 2015		
			Qualitative objectives		**Quantitative objectives**
Natural	**Groundwater**	No deterioration		Good chemical status	Good quantitative status
	Surface waters	No deterioration	Good ecological status	Good chemical status	
Heavily modified	**Surface waters**	No deterioration	Good ecological potential	Good chemical status	
Artificial	**Surface waters**	No deterioration	Good ecological potential	Good chemical status	

5.1 Environmental objectives for surface water bodies

The extension of the Rhine and of some of its major tributaries during the last centuries for the purposes of navigation, flood protection and use of hydropower have resulted in major morphological changes of the water bodies.

42 % of the 191 surface water bodies in the IRBD Rhine (basic network of water bodies, catchment area > 2,500 km²) have been classified as natural, almost half as heavily modified and 9 % as artificial (Figure 28, left). If only the 27 water bodies of the main stream of the Rhine are considered, 93 % of them have been classified as “heavily modified”; the 7 % of natural water bodies are located on the High Rhine and in the coastal waters (Figure 28, right; also, see Map K 6).

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[53] In Germany, “adjustments” are identical with “Exemptions and extensions of deadlines”. In the Netherlands, the notion “exception” is used according to WFD, Article 4, Par. 4 to 7.

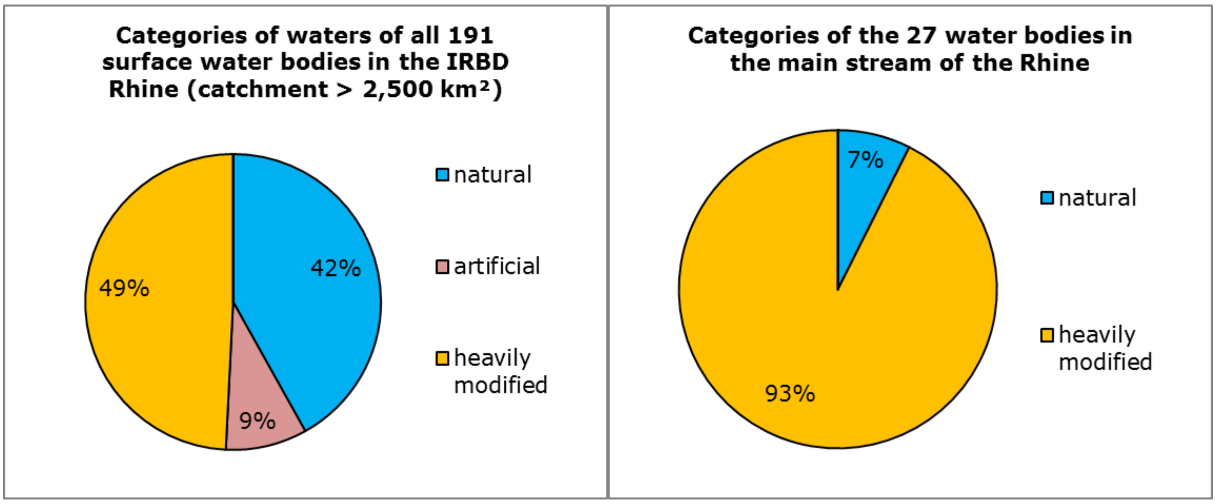

Figure 28: Categories of all surface water bodies in the IRBD Rhine (catchment area > 2,500 km², left) and of water bodies in the main stream of the Rhine (right) based on the number of water bodies. State: December 2015; data without Switzerland, see text for Figure 10

5.1.1 Ecological status / ecological potential

The interstate comparability of the ecological status / potential of water bodies is an important prerequisite for harmonised water protection in international river basin districts (IRBD). In many sections, the rivers Rhine, Moselle and Saar are border rivers, and their water bodies have to be classified by two states. The European Working Group X-GIG Very Large Rivers is working on the intercalibration and classification of biological quality elements according to WFD for very large rivers (catchment > 10,000 km²). All EU-States represented in the ICPR participate in this intercalibration.

The **main problems for large rivers** are lacking reference status and methodical difficulties with respect to the analysis of biological quality elements. Also, the data sets of the different countries are partly inhomogeneous, e.g. with respect to the taxonomic resolution or the kind of contamination.

Due to this situation, it has so far only been possible to intercalibrate the **phytobenthos** which mainly only reacts to one contamination, which is the phosphorus content. Thus, national procedures are similar.

Intercalibration for the next component, the **macrozoobenthos** reacting to a variety of factors is going on. It is among others being discussed, which degree of detail the typology of large rivers in the EU must achieve for intercalibration. The aim is to use as few types as possible. The composition of the "common metric" of general performance indicators and the correlation with aggregated contamination indicators figure among the further issues.

There are sufficient data available for an intercalibration of the quality element **fish**. The question is being discussed, to what extent the floodplain, which is an important element of a river system for the fish fauna, is significant for the classification. So far, most states use procedures which mainly classify the main stream.

The intercalibration of the **phytoplankton** component will presumably be concluded in 2016. On the other hand, few data are available for **macrophytes**.

Intercalibration for very large rivers should be brought to an end by 2016.

Member States determine the criteria for the physico-chemical classification.

Most of the water bodies in the main stream of the Rhine and its tributaries with a catchment > 2,500 km^2 have been classified as "heavily modified" (HMWB). Thus, the good ecological potential (GEP) applies as environmental target. So far, the procedure to derive the GEP has not been intercalibrated. Therefore, it is all the more important to have a common understanding of the GEP in the IRBD Rhine.

For the Management Plan 2009, the ecological potential was determined as a procedure based on measures using the so-called "Prague Approach". The starting point was the joint definition of the highest ecological potential (HEP) as state of a water body resulting from the *implementation of all technically feasible measures aimed at an ecological enhancement of a water body without significant effects on specified uses or the environment at large* (according to WFD Article 4 (3)). The GEP was understood as a gradation, as *all measures with little ecological effect* were subtracted from the HEP.

For the Management Plan 2015, classification procedures have been further developed in the states belonging to the IRBD Rhine, but the EU states resp. federal states/regions have partly chosen different approaches.

The common features and differences of the procedures are relevant with respect to the **harmonisation of classification results at border water bodies** and have been intensively discussed within the IRBD Rhine. Still, in all national procedures apart from Switzerland, the HEP is defined on the basis of measures. In the Netherlands and in Germany, the ecological effects of potentially feasible measures are taken into account and transposed into calculable biological information which can be integrated into classification procedures. In France, the degree of hydromorphological pollution is part of the classification of the ecological potential. For some quality elements on the German-French Upper Rhine the different classification scales have been discussed bilaterally in order to agree upon a common classification (see Annex 1).

A direct comparison of the national procedures is only possible at the level of measures (i.e. based on general catalogues of measures).

National measures implemented in the EU Member States aimed at improving the ecological status resp. potential are described in Chapter 7.1.

Restrictions due to the uses of flood protection, navigation, water regulation and hydropower lead to less favourable living conditions thereby leading to lower values for the biological quality elements than for the good ecological status / potential:

- Lower values are achieved for the quality element macrophytes/phytobenthos (aquatic plants) if the water body only has few shallow water areas, as shallow waters are preferably colonised by macrophytes. Additionally, lapping waves and current caused by navigation restrain the development of aquatic plants;
- The quality element of benthic invertebrates (macrozoobenthos) is impacted by less variation and dynamics of river bed substrate (stones, gravel and sand), a higher substrate share with little organic material and a strong current and permanently shifting substrate in the navigation channel (partly caused by river training and navigation). In addition, benthic colonisation in the navigation lane is clearly dominated by alien species. The reasons may in particular be: spreading due to ships (among others attached to the hulks) and immigration through the canals interconnecting different catchments (e.g. Main-Danube-Canal);
- The quality element fish fauna is mainly affected by the presence and availability of food sources and habitats (in particular spawning grounds). This situation is further aggravated by (heavily) restricted access to spawning waters and diversified habitats and the still restricted continuity of the water body (in particular along the coast, towards tributaries, between the high-water channel and low-water channel).

Even if the "good ecological status" for natural water bodies or the "good ecological potential" for heavily modified waters is possibly not achieved for all water bodies, the aquatic ecosystem of the basic network of water bodies of the Rhine will be considerably and sustainably improved by the implementation of measures. In this connection, the improvement of river continuity is basically also a requirement for heavily modified water bodies.

According to Annex V WFD, "river continuity" is a "hydromorphological quality element supporting the biological elements". Electrofishing near the riverbank is the normal method for fish inventories in large rivers to which the national classification systems refer (IPR in France, fiBS in Germany). (Anadromous) migratory fish which are only occasionally in the water body are rarely detected with this method and the corresponding index result thus only takes them into account based on a comparatively small mathematical influence. A consequence may be that the fish fauna is already classified as “good” in 2014, even though river continuity has not yet been restored and planned improvements of spawning habitats may not have been implemented.

Due to the great importance of migratory fish populations for Level A of the Rhine catchment, the targets of the “Master Plan Migratory Fish Rhine” - among others the restoration of river continuity in programme waters for migratory fish (see below) - are applicable irrespective of the classification of individual water bodies.

Figure 29 (left) illustrates the present assessment (2015) of the states in the IRBD Rhine with respect to achieving the targets for the ecological status / ecological potential of surface water bodies in 2021. This assessment already takes into account the assumed effect of measures implemented in the course of the 2nd management cycle. Accordingly, it is expected, that the targets will be achieved in 14 % of the surface water bodies in the IRBD Rhine (catchment > 2,500 km²). For 80 %, the achievement of objectives is unlikely. For 5 % of the water bodies there is no information on the achievement of objectives available. In the main stream of the Rhine, the objectives are achieved for 7 % of the water bodies.

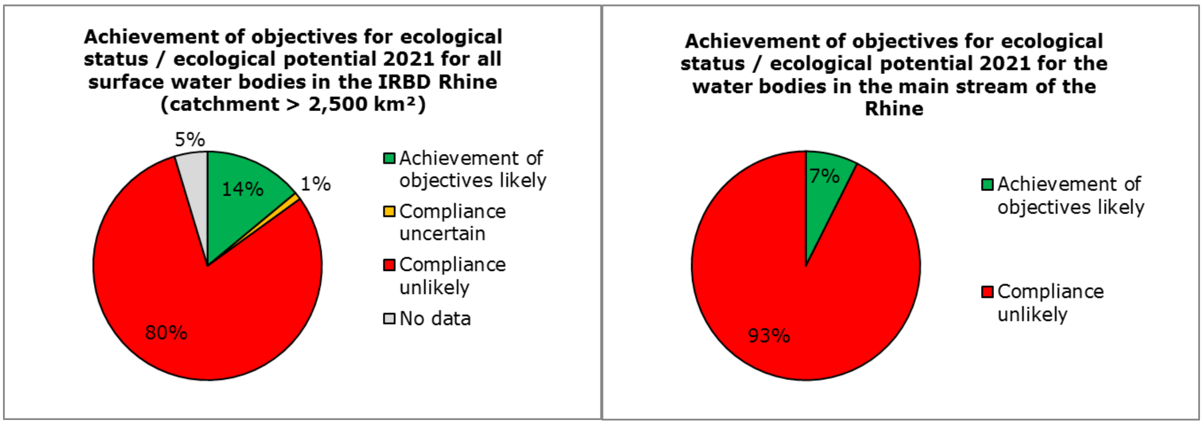

Figure 29: Achievement of target ecological status / ecological potential 2021 for all surface water bodies in the IRBD Rhine (catchment > 2,500 km², left) and for the water bodies in the main stream of the Rhine (right). State: December 2015; data without Switzerland, see text for Figure 10

Continuity of water bodies for fish

An intact river system including the possibility of moving into the marine environment is in particular essential for the survival of diadromous migratory fish. So, for the distribution of migratory fish which spend part of their life cycle in fresh water and another in salt water, the continuity of a river system is an important factor. The migratory salmon is an indicator of the degree of upstream continuity of a water system as it reproduces in freshwater. Eels live in fresh water until they are mature and migrate downstream into the marine area where they reproduce. On their way downstream, they are frequently caught in the turbines of hydropower plants which are not equipped with any fish protection devices or where these devices are insufficient.

Important management questions identified for the IRBD Rhine are the restoration of the continuity of waters (as far as possible) and increasing the habitat diversity. The Conference of Rhine Ministers on 28 October 2013 in Basel again confirmed that the restoration of the migration routes represents an important management aspect within the implementation of the WFD and that of the Swiss law on water protection and that migratory fish also play a role in the implementation of the Marine Strategy Directive. The target to gradually restore the continuity of the main stream of the Rhine as far as Basel and in the salmon programme waters so that migratory fish such as salmon may again reach Basel and the spawning areas for migratory fish in the rivers Birs, Wiese and Ergolz by 2020 was once again confirmed in Basel in 2013.

The lake trout of Lake Constance as the indicator fish species for the Alpine Rhine / Lake Constance area of operation is also considered within the management plans for this area.

For the eel, maturing in fresh water and spawning in the sea, the environmental objective set by the EC eel regulation is to ensure that 40 % of the silver eel reach the sea.

By the end of 2008, all EU Member States with natural stocks of eel submitted eel management plans intended to secure a 40 % minimum survival rate of downstream migrating eel. A survey of national measures in the Rhine catchment 2010-2012 according to the Eel Regulation is included in an ICPR technical report[54].

Reduction objectives for inputs of substances relevant for the Rhine and for physico-chemical elements supporting the achievement of the good ecological status/potential

Physico-chemical elements supporting biological findings are e.g. oxygen, the nutrients nitrogen and phosphorus as well as salts such as chloride and temperature. In most water bodies in the IRBD Rhine (Level A), impairments due to a lack of oxygen and increased chloride contents are no longer relevant. However, increased phosphorus contents continue to play a role. Regarding questions of temperature, please refer to Chapters 2.3, 2.4 and 7.1.2. As described below, the reduction target for nitrogen is based on the protection of the marine environment.

The schedule for reducing the discharge of substances relevant for the Rhine – as far as their relevance is confirmed – will be determined locally in coordination with the Rhine-bordering countries. A reduction at the source is striven for. As far as required, the management reports (Level B) address further specific pollutants or groups of pollutants that must meet national standards or must be taken into account as a matter of precaution.

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[54] ICPR report no. 207 (2013)

Reduction targets aimed at marine protection

The average annual total nitrogen load discharged into the estuary of the Rhine, the coastal waters and the Wadden Sea between 2007 and 2013 amounts to about 232 kilotons (see Chapter 4.1.1).

According to present assessments, the "good ecological status" of the quality element phytoplankton, in particular of the sensitive ecosystem of the "Wadden Sea" may be achieved, if a maximum annual load of on average 227 kt total nitrogen discharges from the Rhine catchment area into the North Sea and the Wadden Sea is not exceeded. Based on the average annual load during 2000 to 2006, this would correspond to an average reduction of about 46 kt N/year (about 17 %).

Development since 2009

This convened load reduction of 17 % will be achieved when the annual average value for total N in the Rhine at Bimmen/Lobith and in the North Sea estuary will not exceed 2.8 mg/l (working unit). In the past years, the average annual values of total N at Lobith are in the range of the working unit 2.8 mg/l (see Table 9 in Chapter 4.1).

This reduction in total N has led to a stable, good status of the phytoplankton on the Dutch coast. For the coast of the Wadden Sea and the Wadden Sea this status is not yet as stable as along the Dutch coast. In the eastern part of the Wadden Sea, the status is worse than in the western part.

During the second management period, the impact of the nitrogen inputs of the Rhine on the water bodies of the eastern Wadden Sea will be checked. Furthermore, the relation with the nutrient norm applied today for salt water and fresh water of the Rhine will be checked.

Due to the prognosis for N emissions in 2021 (see section 7.1.2), it is assumed that the concentration will continue to fall during the coming years.

5.1.2 Chemical status

Figure 30 and Map K 27 illustrate the present assessment (2015) of the states in the IRBD Rhine with respect to achieving the objectives for the chemical status of surface water bodies in 2021. This assessment already takes into account the presumable effect of supplementary measures taken / to be taken during the 2nd management cycle and based on the risk assessment 2012/2013. Accordingly, the objectives will be achieved in 3 % of the surface water bodies in the IRBD Rhine (catchment > 2,500 km²). For 96 %, the achievement of objectives by 2021 is unlikely. No prognosis was presented for 1 % of the water bodies. In the main stream of the Rhine (right hand graph), the objectives will be achieved for 11 % of the water bodies.

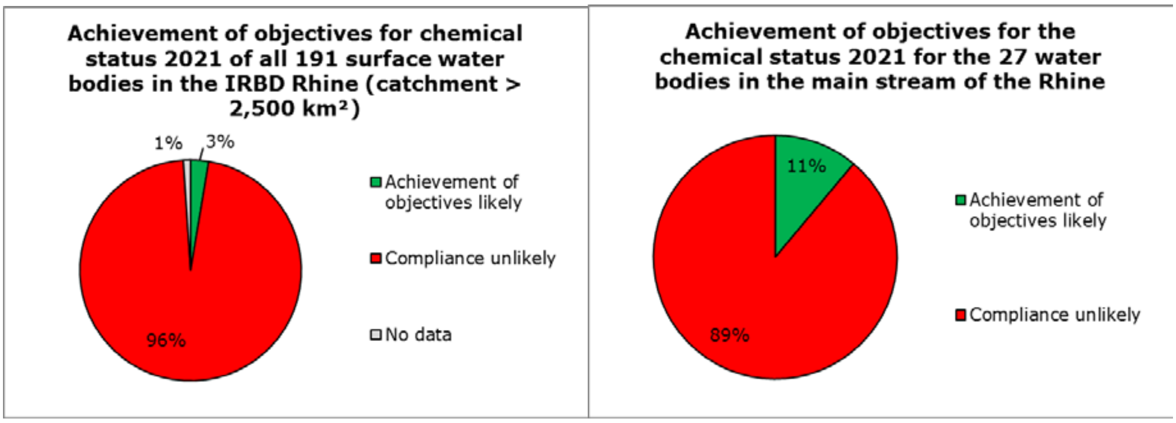

Figure 30: Achievement of objectives for chemical status 2021 for all surface water bodies in the IRBD Rhine (catchment > 2,500 km^2, left) and for the water bodies in the main stream of the Rhine (right). State: December 2015; data without Switzerland, see text for Figure 10

The low degree of achievement of objectives expected for 2021 is correlating with the ubiquitous PAH and mercury contamination in numerous surface water bodies of the Rhine catchment for which improvements are only gradually expected. Furthermore, the EQS for the substance fluoranthene not classified as ubiquitous is largely neither achieved in the main stream, nor in the catchment (see Chapter 4).

5.2 Groundwater

As far as groundwater is concerned, the target is to prevent noxious changes of the quantitative and chemical condition.

The environmental objectives of the “good quantitative status” and “good chemical status” are explained in Chapter 4.2.

The general wording of the objectives will be specified by the states or federal states/regions. It has been discussed within the ICPR as to how implementation will be performed in the states or federal states/regions. In terms of the coordination which is required for this further elaboration, a distinction is made between surface waters and groundwater. Sometimes, hydraulic links to groundwater bodies exist at the borders between federal states and between states. In these cases, the classifications and the measures required to achieve the objectives are coordinated bilaterally, e.g. between the Netherlands and the German federal state North Rhine-Westphalia.

Therefore, a coordination of objectives for groundwater is limited to neighbouring states (on level B). A more detailed description of the objectives for groundwater and the corresponding coordination is given in the relevant reports on level B.

Moreover, the WFD stipulates the requirement that the “Member States implement the required measures, in order to reverse the trend in all cases of sustained upward trends of pollutant concentrations due to human activities”.

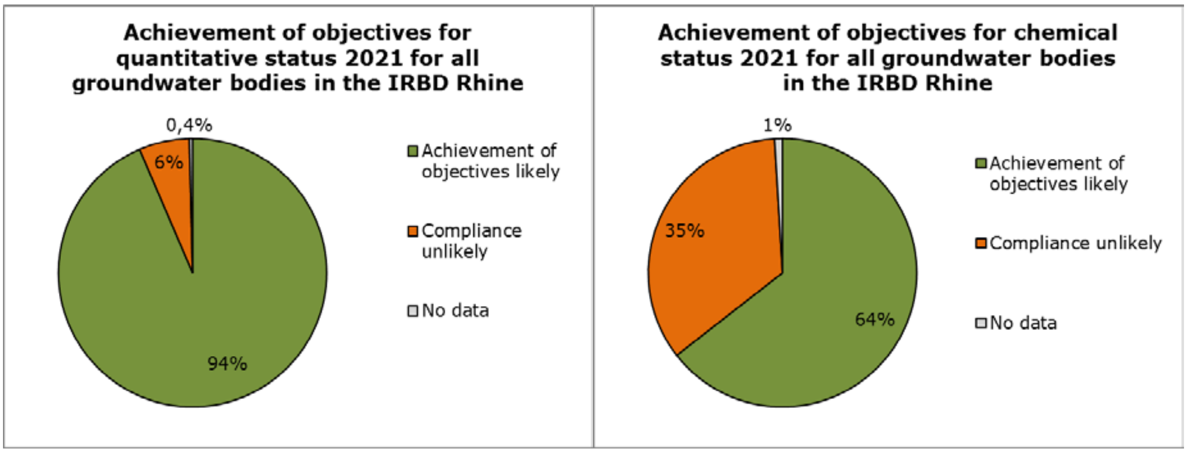

Figure 31: Achievement of objectives for quantitative status (left) and chemical status (right) in 2021 for all groundwater bodies in the IRBD Rhine. State: December 2015; data without Switzerland, see text for Figure 10

Figure 31 (left) and Map K 28 show today's assessment (2015) of the states in the IRBD Rhine with respect to the achievement of objectives for the quantitative status of groundwater bodies in 2021; Figure 31 (right) and Map K 29 represent the corresponding data for the chemical status of groundwater bodies. This assessment already takes into account the assumed effect of measures implemented in the course of the 2nd management cycle.

Accordingly, it is expected that, in 2021, 94 % of the groundwater bodies in the IRBD Rhine (catchment > 2,500 km²) will achieve the objectives of a good quantitative status. For 6 %, the achievement of objectives is unlikely.

With respect to the chemical status, it is expected that, in 2021, 64 % of the groundwater bodies in the IRBD Rhine (catchment > 2,500 km²) will achieve the objectives of a good chemical status. For 35 %, the achievement of objectives is unlikely. For 1 % there are no data available.

5.3 Protection areas

Article 4, Par. 1, c WFD determines the objectives for protection areas: Member States shall "achieve compliance with any standards and objectives at the latest 15 years after the date of entry into force of this directive unless otherwise specified in the Community legislation under which the individual protected areas have been established". For these objectives, mainly the adaptation possibilities offered by the WFD apply.

Thus, two kinds of objectives must be achieved for protected areas: the specific objectives of the directive concerned and which were decisive for the designation of an area (see WFD Annex 4) and the individual national standards of implementation and objectives of the WFD. The protected areas to be considered are listed in WFD Annex IV. Some protected areas correspond to water bodies. They correspond to:

- On the one hand, (present and future) water bodies for human use and to be designated according to Article 7, par. 1 WFD. On a daily basis, these water bodies deliver more than 10 m³ of water for human consumption or deliver such water to more than 50 people;
- On the other hand, water bodies used for bathing and water sports.

The other protected areas do not exclusively consist of water bodies:

- "Sensitive" areas in the sense of Directive 91/271/EEC on the treatment of municipal wastewater;
- "Areas at risk" in the sense of Nitrates Directive 91/676/EEC concerning the

protection of waters against pollution caused by nitrates of agricultural origin;

- Habitat and species protection areas if, according to the Habitats Directive 92/43/EEC of 21 May 1992 concerning the protection of natural habitats and wildlife fauna and flora and the Bird Protection Directive 79/409/EEC of 2 April 1979 concerning the preservation of bird wildlife, conservation or improvement of the state of the water is an important protection factor.

In the meantime, the Directive 2006/44/EC of 6 September 2006 on the quality of fresh waters needing protection or improvement in order to support fish life and the Directive 2006/113/EC of 12 December 2006 on the required quality of shellfish waters quoted in the WFD and mentioned in the Management Plan 2009 have been repealed.

Please refer to explanations given in Chapter 3 and relevant maps.

5.4 Adapting environmental objectives for surface waters and groundwater, reasons

5.4.1 Extension of deadlines

The deadline set for 2015 to achieve the good status or the good potential of water bodies can, at maximum, be extended by 12 years (i.e. two revision periods of the Management Plan) unless natural circumstances are the reason for why management objectives may not be achieved within this period of time.

An extension of the deadline is only possible, if one of the following three reasons is given:

- Due to **technical feasibility**, the improvements required to achieve the good status can only be carried out in several steps beyond the deadline set to 2015. If e.g. the preparatory phase for work (studies, definition of performance) or implementation is too long to be able to achieve the good status in 2015, this may justify an extension of deadline due to "technical feasibility";
- **Natural conditions** prevent improvement of the status of water bodies within the deadlines set. If the improvement of the environment after implementing rehabilitation measures takes some time, this may justify an extension of deadline due to natural conditions;
- Costs for the implementation of required improvement measures within the deadline set cannot be borne by the Community. In this case, an extension of the deadline may be filed due to **excessive costs**. Another aspect to be taken into account is disproportionateness resulting from considerations of cost-effectiveness.

In the IRBD, extensions of deadline (A – water network, catchment area >2,500 km²) are justified as follows:

Surface waters

To achieve the good ecological status / potential of the surface water body

To restore river continuity and increase the habitat diversity of natural, artificial and heavily modified surface waters, disproportionate costs, natural conditions or technical feasibility are taken into account when claiming an extension of deadline.

For phytoplankton in coastal waters

Since 2012, the coastal water body “Dutch coast” presents a good status. The status of the Wadden Sea coast and of the Wadden Sea is not yet stable, it varies between moderate and good. With the ongoing further implementation of corresponding EU directives and of national programmes of measures further reductions of nitrogen loads are to be expected.

For the substances relevant for the Rhine: zinc, copper and the group of PCBs

For technical reasons it is today not possible to replace the uses of copper and zinc by other, less polluting substances. Since there is a ban on the substance, PCBs have not been produced or used for a long time. Due to their ubiquitous spreading, historic contaminations with these substances will continue to pollute water sediments and biota.

For phosphorus

Apart from inputs born by wastewater, diffuse inputs are also the reason for exceeding the national values or recommendations for the nutrient total phosphorus on the northern Upper, Middle and Lower Rhine and for ortho-phosphate-phosphorus in almost all tributaries of the Rhine analysed.

For priority (hazardous) substances

In particular, the group of substances of polycyclic aromatic hydrocarbons (PAH) and mercury (measured in biota) are concerned. These substance discharges are due to many widespread applications or to atmospheric deposition (ubiquitous substances). Operational measures have already been taken. With respect to further measures addressing these substances, a coordinated approach must be developed at a level beyond the catchment and at least at EU level comparable to that for mercury introduced with the Minamata agreement (see Chapter 7.1.2).

Regarding the priority substances only relevant at few monitoring stations reference is made to the Part B reports.

Groundwater

Nitrogen in groundwater bodies

- Natural conditions

Intensive agriculture today results in high concentrations of nitrate in many groundwater bodies. Due to natural conditions, these concentrations are only drained off very slowly by surface water bodies. Even if all measures aimed at reducing the surplus of the balance and resulting from EC laws supported by environmental measures in agriculture and supporting instruments of the states are successful, it will take longer than 2021 until all groundwater bodies will have achieved the good chemical status.

- Economic reasons

When resorting to deadline extensions for groundwater bodies, disproportionate costs for all of the measures to be implemented are also taken into account. Therefore, it is necessary to extend the measures aimed at achieving the objective to several management plans.

Achieving the good quantitative status

The poor quantitative status of the two groundwater bodies in the German federal state Rhineland-Palatinate has not been improved by 2015, as no reduction of groundwater abstraction has so far been implemented. Due to the hydrogeological situation of the region it proves to be difficult to develop substituting sources. Therefore, an extension of deadline until 2021 is required.

Achieving the good chemical status

In some areas, the chemical status of groundwater bodies has not fundamentally changed compared to 2009 and an extension of the deadline until 2021 resp. in some cases until 2027 is required. Also, long flow and residence times with retention times up to several decades could delay the effect of measures. Furthermore, there may be technical reasons for requesting an extension of deadline, such as the necessity of analysis and development of restoration measures and uncertainty with respect to the effect of certain measures.

5.4.2 Determination of less stringent objectives

For certain water bodies, less stringent objectives than the achievement of the good chemical, ecological or quantitative status or the good ecological potential may be determined. To this end it must be proven that, with respect to certain parameters or to water quantity, these water bodies are impacted to such an extent by human activities or their natural state is such that it is not possible to achieve the objective or achievement would cause disproportionate costs.

Surface waters

This possibility is not being used for Part A surface waters.

Groundwater

In a few cases, less stringent environmental objectives according to Article 4, par. 5 and 7 WFD are required and briefly explained below:

Open-cast lignite mining areas on the left bank of the Lower Rhine are conducted in open pits with a depth of several hundreds of meters. In order to ensure safe mining activities, the groundwater level must be lowered considerably. In the long run, lowering the groundwater level and the mining activities above all impact the quantitative groundwater status, but also the chemical groundwater status (e.g. sulphate, heavy metals and ammonium). Thus, in this area, some groundwater bodies will remain in a “poor” quantitative and qualitative status for decades to come (term of opencast mining: presumably 2045).

Limestone mining in the Wuppertal area also involves draining measures so that, for the long term (mining activities until 2048), two small groundwater bodies present a “poor” quantitative status.

5.4.3 Exceptional status deterioration

Exceptions from the environmental objectives due to changes of or impacts on the water bodies are possible, if the deterioration corresponds to an “overruling general interest”. At present, this does not apply to Part A.

6. Economic analysis

The WFD integrates economic aspects into European water policy. Within the survey and for management plans it requires:

- An economic analysis of the water use presenting the economic background for present uses and contaminations of the water bodies (WFD Article 5, indent 3 and Annex III).
- A prognosis for the development of anthropogenic activities for the management period to come (until end 2021) within the so-called baseline scenario (WFD Article 5, indent 2 and Annex III).
- To take into account the principle of covering the expenses for water services, including environmental and resource-related expenses (WFD Article 9 and Annex III).

On the one hand, the economic analysis contributes to pointing out the socio-economic importance of water use. On the other hand, the anthropogenic causes (“driving forces”) behind the present pollution of waters are represented. Thus, the economic analysis of water use gives information required for planning measures.

The following presentation is a trans-national summary. With respect to identifying the most cost-efficient combination of measures (WFD Annex III, b), reference is made to the detailed presentations in the management plans (B Parts). Chapter 7.2.2 gives information on the recovery of costs for water services.

6.1 Economic importance of water use

The economic description of water use underlines the economic importance (for value added, labour market and the supply of the population and of economy with required goods and resources) and the material extent of water use (abstraction or amount of discharge) for a catchment. This establishes a connection between economic activities and the environment.

Population

About 60 million people live in the nine states of the IRBD Rhine (basis: 2010). That amounts to about 2 million more than in 2000. The average population density represents about 300 inhabitants/km², however, the population is not evenly distributed over the different states. With about 160 inhabitants/km² Austria has the least population density in the IRBD Rhine, while the German federal state North Rhine-Westphalia has the highest population density with 515 inhabitants/km² (see Table 2).

Almost the entire population (about 99 % in 2000) living in the IRBD Rhine is connected to public drinking water works.

In 2000, households and small businesses in the IRBD Rhine consumed about 2.6 billion m³ drinking water. On average, this corresponds to about 130 l per inhabitant per day. During the last years, the water consumption continued to drop. In the Netherlands, in 2013 e.g., the average consumption per inhabitant and day amounted to 119 l.

The major part (about 96 %) of the population in the IRBD Rhine is connected to a wastewater treatment plant. Only in the Moselle-Saar sub-basin this percentage is slightly lower (85 %).

On average, 2 % of the population in the IRBD Rhine have septic tanks, which means that about one million inhabitants thus dispose of their own treatment system.

Today, the treatment capacity of the wastewater treatment plants in the IRBD Rhine amounts to about 100 million population equivalents. At present, this treatment capacity which has hardly changed during the past years covers the requirements of the population and of those industrial plants connected to a public sewage treatment plant.

Agriculture

During the second half of the last century, agriculture in Europe, and therefore also in the IRBD Rhine, has been considerably intensified. Among others, due to the progressive extension of the exploitation only a few per cent of the working population are working in agriculture. About half of the surface of the international river basin district Rhine is being used for agricultural purposes.

According to the Management Plan 2009, the total added value in agriculture amounted to some 27 billion Euros. There are no more recent data available.

Industry

Over the last few centuries, industrial activities in the IRBD Rhine concentrated particularly on the metal processing and chemical industry. During the last century, coal and nuclear power plants producing energy and refineries settled in the area.

According to the Management Plan 2009, more than six million people corresponding to about 20-30 % of the working population living in the entire IRBD, work in industry. There are no more recent data available.

To give an idea of the development in one of the most important industrial areas in the Rhine catchment during the past years, some facts and illustrations of the chemical industry in the European Union are given[55], however without wanting to give the impression that this applies “pars pro toto” for the entire industry.

In 2013, the value of the worldwide chemical production amounted to some 3,165 billion Euros. In 2003 it amounted to about 1,326 billion Euros. In 2003, the EU dominated with a share of approx. 31 %, in 2013, China dominated and the share of the EU sank to just under 17 %. The economic crisis has distinctly impacted the production in the EU (see Figure 32).

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[55] Cefic, The European chemical industry

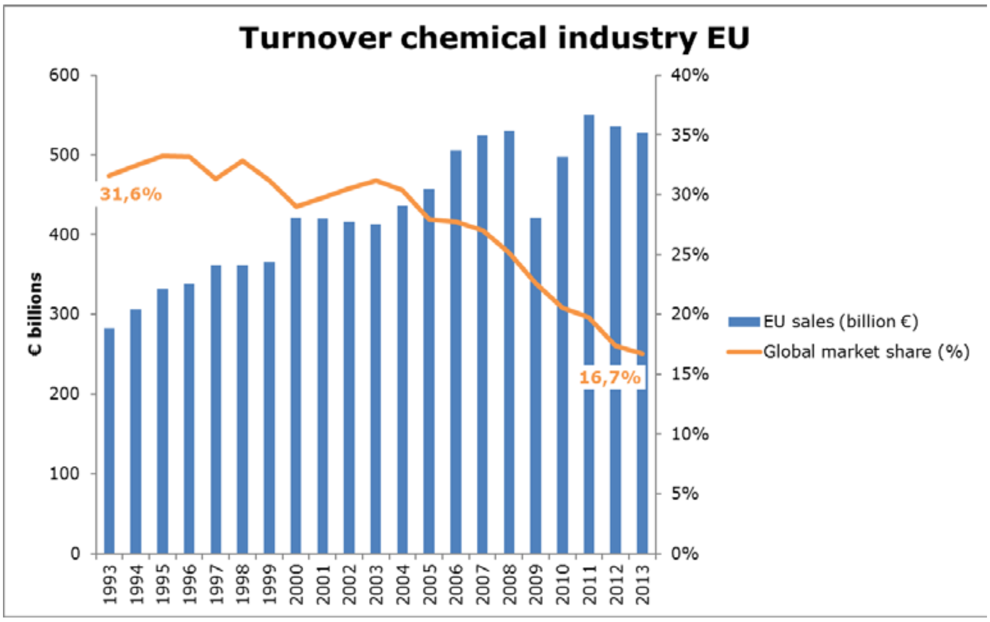

Figure 32: Turnover of the chemical industry in the EU. (Source: Cefic, The European chemical industry, Facts and figures 2014 (http://fr.zone-secure.net/13451/106811/)

In 2000, there were about 1.45 million direct employees in this sector. Ten years later, in 2010, there were 1.17 million employees in this sector and employment has been stable ever since.

Hydropower plants for power generation

Today, the hydropower of the IRBD Rhine is intensively used for power generation. There are 24 hydropower plants along the Rhine between the confluence of the Anterior and Posterior Rhine to the estuary of the North Sea.

The installed power of the hydropower plants along the Rhine and its most important tributaries is more than 2,200 MW. The greatest concentration of power plant production is to be found on the High Rhine and the southern Upper Rhine. Before extending the Iffezheim power plant as of 2009, the maximal total production of all 10 hydro power plants on the Upper Rhine amounted to 1,400 MW, while the average production per year amounted to 8.7 billion kWh per year[56]. During 2009 to 2013, a fifth turbine was installed at the Iffezheim power plant. Small power plants (weir turbines) have been installed in the new fish passages at the impoundments in Strasbourg and Kembs/Märkt.

All in all, some 305 hydro power plants are installed in the network of water bodies part A (catchment > 2,500 km²) (only transverse structures with more than 2 m height of fall, state: 02 October 2014).

Even in the tributaries hydropower plays an important role.

Navigation and transport

Navigation has long been an important use of the Rhine. As early as 1868, regulations were determined for navigation (Act of Mannheim 1868). From its outlet into the North Sea until Basel some 800 km further upstream the Rhine is being used as waterway.

At present, the Rhine is the by far the most important waterway in Europe: about two thirds of the entire transport of goods on European waterways is passing by the Rhine. The Rhine and the Moselle have a status as international shipping lane; their use is regulated by international treaties. Apart from national transport, the goods handled in the ZARA-ports (Zeebrugge, Amsterdam, Rotterdam and Antwerp) are transported on

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[56] Information board at the Vogelgrün power plant, July 2015

the Rhine and its adjacent waterways to the Netherlands, to Germany, Luxembourg, Belgium, France, Switzerland and into the Danube area. On the other hand, the Rhine is also used for the transportation of export goods.

Inland navigation is an important part of long distance bulk goods transportation, e.g. for cheap transportation of fuel from the sea ports to power plants further inland, for the transportation of ore and coal to the steel works, of chemical products towards and from chemical industry sites, of oil products towards and from refineries and tank farms. The largest volume is being transported by the Rhine bordering countries Netherlands and Germany.

Annually, more than 300 million tons of goods are transported on the navigable Rhine between Rheinfelden/Switzerland and the North Sea. 200 million tons are transported on the section called the traditional Rhine between Rheinfelden and the German-Dutch boarder.

Two thirds of these goods transported are dry bulk goods and end products (such as metals and metal products), one quarter are fluid bulk goods and one twelfth are containers (see Figure 33). Container shipping represents a transportation market growing above average. Present prognosis announces a further increasing trend. Between 2000 and 2013 the container traffic on the Rhine doubled. Regardless of this enormous increase, considering the volume, the container traffic on the Rhine plays a relatively small part (8 % of the entire transported volume). Nevertheless, the share in value added is considerably higher.

Big ports such as Rotterdam, Duisburg, Strasbourg or Basel are located on the Rhine.

A further important development is the increase in the average size of ships. In order to keep up navigation, maintenance measures must be carried out on the banks, in the riverbed and regarding infrastructures. These measures e.g. include restoring revetments, dredging and assuring the required depth of the waterway, adding bedload substitution material and restoring groynes. Regularly, maintenance measures are also required in installations such as locks, berthing areas and ports.

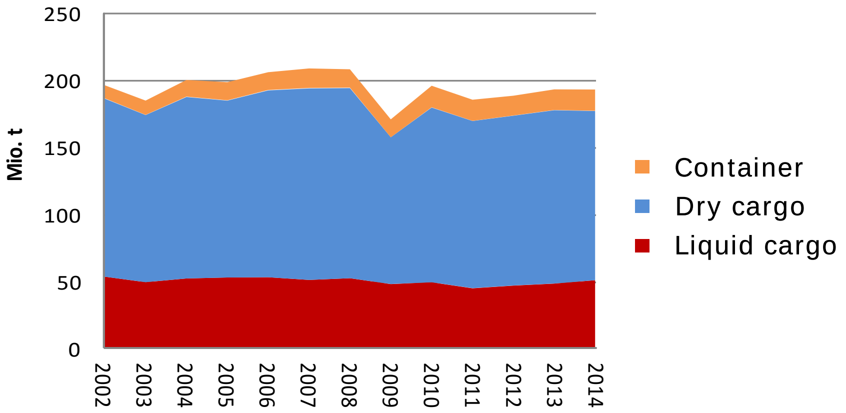

Figure 33: Distribution of the transportation volume in Rhine navigation. (Source: Marktbeobachtungen Nr. 18, Binnenschifffahrt 2013 und Vorausschau 2014/2015, ZKR, EU und Panteia, Straßburg, September 2014)[57]

In Germany, about 7,500 persons work in inland navigation. In 2010, the inland waterway carriers registered a net turnover of about 1.3 billion €. Due to a gradual recovery from the consequences of the economic crisis, in 2013, the net turnover rose to almost 1.6 billion €. For the Netherlands, inland navigation continues to be a comparatively large sector representing 17,500 employments and a turnover of 2.7 billion € in 2013.

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[57] Marktbeobachtungen 2014

Lake Constance is important for leisure navigation and the tourism infrastructure. The International Commission for Navigation on Lake Constance (ISKB) founded in 1973 deals with uniform regulations for shipping equally comprising exhaust emission standards. At present, some 58,000 boats/ships are registered on Lake Constance.

Fishery, tourism, sand and gravel pits

In 2012, the revenue of fishery in the Netherlands including the Dutch continental shelf amounted to 175 million € and was about 47 million € (well 20 %) below the revenue in 2002 (222 million €). For the Dutch fishery, the Rhine delta is the most important area. The most important segments of Dutch fishery are fishing from small vessels, deep sea fishing and mussel and oyster farming. Fishing in Lake IJssel and in other inland waters is of less importance.

Other uses, such as water tourism, e.g. on the Moselle and Lahn rivers, the operation of sand and gravel pits are only of regional importance.

6.2 Baseline Scenario

The “baseline scenario” with its 2021 deadline is to provide insights into the presumable development of water uses with decisive impact on the status of the water bodies. After a description of the actual situation of water uses (Chapter 6.1) the development of anthropogenic activities until 2021 is to be assessed within the framework of the risk analysis. It considers the development of the population, of economy and surface use as well as the following water uses (water abstraction and wastewater discharge, agriculture, navigation).

Apart from the development of relevant socio-economic parameters and the development of anthropogenic parameters liable to impact the pollution of water bodies, the risk analysis takes into account the effects of WFD measures implemented by 2015, and of climate development and its effects on water management.

Increasing demand for biomass products and exportation of foodstuff are e.g. expected to lead to increased production in agriculture. It is assumed that, at the same time, existing environmental standards are taken into account and thus the impacts of agricultural water use on the pollution of water bodies remains unchanged. Navigation as well as the percentage of hydropower generation might also increase. The navigation on the Rhine is expected to increase by 3.5 % of the transported volume in 2016.

No data on the gross value added of business in all states of the international river basin district Rhine have been gathered. Even though the global financial crisis which began in 2007 seems to be regressing in the past years, it is difficult to assess its effects.

Apart from the most recent migration developments, the demographic change is liable to lead to a declining population in the Rhine catchment with an increasing share of elder citizens (see Figure 34). However, regionally and locally, the population development will differ. For spatial technical infrastructures such as water and wastewater this development requires an adaptation, since the efficiency of these infrastructures above all depends on the population density. If the number of users decreases, additional technical changes could be required due to operational issues.

For the water and wastewater infrastructure systems, a high capital ratio and a long service time particularly of the pipelines demand local flexibility. This again requires foresighted planning and taking into account changing prerequisites on the long term.

Concerning the effects of the demographic change, a differentiation may be made between operational effects on water distribution, wastewater transportation systems and wastewater treatment plants and ecological, structural and economic effects. A declining number of inhabitants leads to less water consumption. Changes in the use of pharmaceuticals due to an ageing population may lead to higher concentrations of pharmaceutical residues in the wastewater. Less water consumption may lead to deposits, corrosion, and odour development and to an unfavourable C/N relationship due to decomposition in the canal. An adaptation of capacities of the sewer and the wastewater treatment plants may perhaps be required, eventually plants must even be shut down and dismantled.

For water supply and for sewage disposal, decreasing numbers of users mean less water and wastewater volumes which, considering today's rate structures mean less revenue.

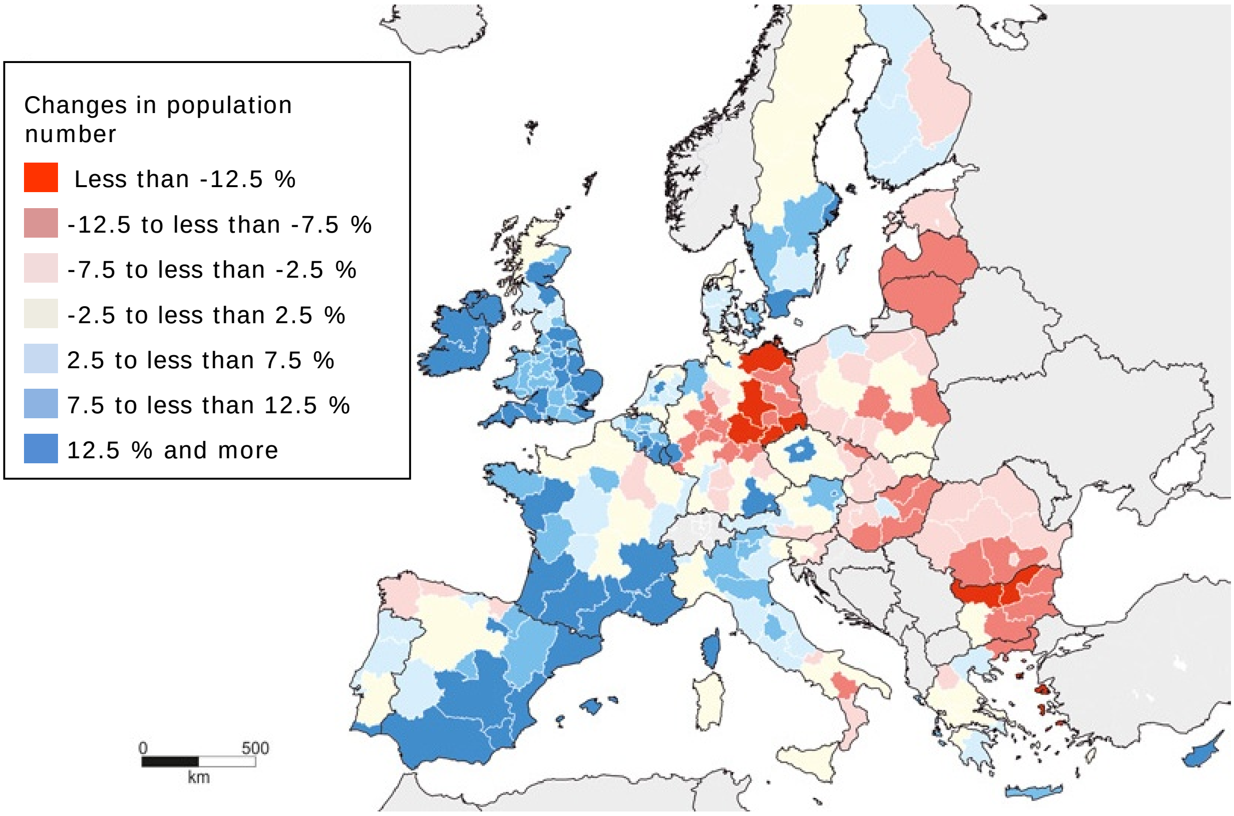

Figure 34: Population development in the EU NUTS-II regions (2010-2030). Data souce: Eurostat (© Paul Gans)

7. Summary of the programmes of measures

7.1 Summary of measures to solve the major management issues in the international Rhine river basin district

In Chapter 7.1 the measures of the EU states resp. federal states / regions aimed at solving the major management issues in the IRBD Rhine are summarised. On the one hand they relate to **measures implemented during 2009 to 2015** and on the other hand, this chapter deals with the **pending measures within the 2nd Management Plan 2015 - 2021.**

Most EU Member States or federal states/regions give, according to WFD Art. 4, Par. 4d, already an **outlook on measures within the 3rd cycle between 2021 and 2027** aimed at progressively achieving the required "good ecological status" or "good ecological potential" by the end of the extended deadline. Following an evaluation of the effectiveness of the measures under the Management Plan 2009 - 2015, these planned measures will be further developed for the second and third cycle of the WFD until 2027.

7.1.1 Restoration of biological river continuity, increase of habitat diversity

As a result of the successful restoration of Rhine water quality under the Rhine Action Programme (resp. the following "Rhine 2000" and "Rhine 2020" programmes), the biocoenosis of the Rhine has recovered. As the analysis of the implementation of the programme "Rhine 2020" within the Management Plan 2015 shows (see Figure 35 and Figure 36), considerable progress has been made with respect to restoring river continuity and increasing habitat variety in the Rhine catchment. Further action is required to achieve the good ecological status or potential.

Further measures for achieving a greater variety of habitats and species along the main river are included in the concept on achieving a vast, ecological and functioning network of biotopes according to the principle of stepping stones described in the report and the atlas of the ICPR "**Habitat Patch Connectivity along the Rhine**"[58]:

- granting of the required minimum flow;
- vitalisation of the water body (among others river bed, variation, substrate) within the existing profile;
- habitat improvement in the water body by changing the river course, design of riverbanks or river bottom;
- improvement of habitats in the corridor of water body development including floodplain development;
- connecting side waters, oxbow lakes (establishing a transverse network);
- improve the bedload balance.

The concept gives evidence of the potential for preserving, improving and interconnecting valuable types of biotopes along the Rhine from Lake Constance to the sea, it sets out precise development targets for sections of the Rhine and fixes distinct spatial focal points. It simultaneously serves water protection, nature protection as well as flood protection. To prepare the planned success control when establishing this network of biotopes, the projects and measures planned or carried through during 2005 to 2013 within the "Habitat Patchwork Connectivity Rhine" were published in a survey report.[59] It will probably be possible to report on the results in the 3rd Management Plan.

The effects of the programmes of measure on the biocoenosis cannot always be clearly distinguished from natural biological interactions. Even though the present ecological classification of the Rhine ecosystem as presented in Chapter 4.1 only represents today's system status, distinct and sustainable ecological improvements can be seen in the long

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[58] Habitat Patch Connectivity along the Rhine (2006); Atlas Habitat Patch Connectivity along the Rhine (2006)

[59] ICPR report no. 223 (2015)

term trends of the last 20 years. Table 11 shows how the future implementation of different ecological measures could contribute to continue this trend.

In the following, general and specific measures are described which may further improve the conditions of life for flora and fauna in the Rhine and its tributaries, in other words, which may improve the ecological performance of the entire water system.

Table 11: Ecological measures in the main stream of the Rhine

Measure	Effect on biological quality element					Where observed
	Macrozoobenthos	Fish fauna	Phytoplankton	Phytobenthos	Macrophytes	
Reduction of nutrient pollution		(+) more natural biocoenosis, less biomass	(+) more natural biocoenosis, less biomass	(+) more natural biocoenosis	(+) enhancement of stocks by less shading of the water bottom (less phytoplankton)	Entire main stream of the Rhine (see ICPR report no. 224, 226, 228)
Removal of riverbank structures (in particular riprap structures) / reduction of the extent of engineering of riverbanks	(+) enhancement of species diversity	(+) reduction of alien gobies			(+) enhancement of species diversity	entire stream of the Rhine (see ICPR report no. 223)
Parallel constructions or filled-up groynes as shallow replacement habitats rich in structure, and protected from the lapping of waves.	(+)	(+) in particular enhancement of juvenile fish	(+)	(+)	(+)	Middle Rhine, Lower Rhine, Delta Rhine (see ICPR reports no. 225, 228)
Improved reconnection of tributaries, alluvial waters and backwaters / lateral river continuity	(+) re-settlement of native species from refuges in the tributaries	(+) enhancement of species spawning on plants and gravel; favouring the reproduction of rheophile species (rudd, pike, tench); juvenile fish habitat for other species			(+) spreading of seeds	Entire main stream of the Rhine (see ICPR report no. 223, and Chapter 7 in the 2nd Management Plan for the Rhine)
Construction or optimisation of structures for up- and downstream fish migration		(+) Long distance migratory fish reach spawning waters; middle-distance migratory fish may change habitat (according to their life-cycle); linking of local population shares => enhanced fitness			(+) spreading of seed with upstream migrating fish (zoochory)	Delta Rhine Upper Rhine High Rhine and tributaries of the Rhine (see Annex 7 in the 2nd Management Plan for the Rhine)

Restoration of river continuity

In the river basin district Rhine, diadromous fish species are of major importance for the network of water bodies at Level A (> 2,500 km²). These are migratory fish moving between fresh and salt water and which thus spend one phase of their life in the sea and one in the Rhine or its tributaries.

Since the "Rhine Action Programme", the **salmon** (*Salmo salar*) is a symbol representing many other migratory fish species, such as sea trout, sea lamprey and eel. In the Alpine Rhine / Lake Constance sub-basin, the **Lake Constance lake trout** (*Salmo trutta lacustris*) is the only long-distance migratory fish and is considered as indicator species. A successful programme aimed at saving this migratory fish species living in Lake Constance, and spawning in its tributaries, in the Alpine Rhine and its tributaries has been going on for about two decades (see below).

Within a "**Comprehensive fish-ecology analysis** including an assessment of the effectiveness of ongoing and planned measures in the Rhine catchment aimed at reintroducing migratory fish" [60] the ICPR commissioned a study in 2008 concerning the measures expected to be most effective within the establishment of self-sustaining populations. According to this study, in the so-called programme waters of the Rhine catchment, as many identified spawning and juvenile fish habitats as possible must again be made accessible and/or revitalised. To this end, among others things, upstream migration must be improved.

In particular the salmon characterised by a very strong homing depends on the accessibility of these waters from the sea.

Based on the above mentioned study the ICPR drafted a "**Master Plan Migratory Fish Rhine**" in 2009. This Master Plan indicates how self-sustaining, stable populations of migratory fish can again be settled in the Rhine catchment area as far as the Basel area within reasonable time and at reasonable costs.

A progress report states the implementation of the Master Plan Migratory Fish during 2010-2012.[61]

Results of the Conferences of Rhine Ministers

The 14th Conference of Rhine Ministers in 2007 confirmed its intent to gradually restore river continuity in the Rhine upstream to Basel and in the salmon programme waters. The 15th Conference of Rhine Ministers stated that due to ongoing measures, river continuity upstream as far as Basel is becoming more and more realistic and plannable. This will open the access to the existing spawning grounds of migratory fish in the rivers Birs, Wiese and Ergolz by 2020.

Furthermore, the 15th Conference of Rhine Ministers confirmed that, in order to achieve the objectives of the programme Rhine 2020 and of the Master Plan Migratory Fish Rhine in the main stream of the Rhine

a. the Haringvliet locks on the North Sea coast will partly be opened in 2018;

b. the fish passage at the Strasbourg impoundment will start operating in 2015; the same year, construction work on the fish passage at the Gerstheim fish passage will start in order to reconnect the Elz-Dreisam area with the Rhine;

c. the experience and assessment of the effectiveness of the fish passages so far built in the river system will contribute to improve the technical solutions still to construct;

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[60] ICPR report no. 166 (2009); ICPR report no. 167 (2009)

[61] ICPR report no. 179 (2009); ICPR report no. 206 (2013)

d. the transfer of fish into the old bed of the Rhine in the region around the impoundment Vogelgrün/Breisach is a technical challenge. With respect to the upstream migration through the Upper Rhine until Basel, the ICPR was charged to facilitate an exchange of experience of experts in 2014, taking into account the results of studies existing so far in order to contribute to finding a technically optimal solution;

e. an efficient fish passage system at the impoundments Rhinau, Marckolsheim and Vogelgrün on the Upper Rhine must be planned and implemented, so that, by 2020, fish may reach the old bed of the Rhine and Basel.

Map K 30 presents the success achieved in restoring the continuity towards the spawning and juvenile fish habitats in the migratory fish programme waters since 2009 (see Map K 14.2 of the Management Plan 2009).

The survey in Annex 7 shows, in which programme waters for migratory fish transverse structures have already been or are being modified with a view to river continuity (highlighted in green) or where such measures are planned until 2018 (highlighted in yellow). Furthermore, a non-binding outlook is made on measures planned until 2027 or beyond (highlighted in orange). These will only take shape in the 3rd Management Plan for the IRBD Rhine. Also, information is given on the improvement of the quality of habitats in these water bodies.

All in all, during 2000 to 2012, 480 measures aimed at improving river continuity in the programme waters have been implemented (see Figure 35).

These measures will also have a positive effect on other fish species and the entire aquatic fauna and flora.

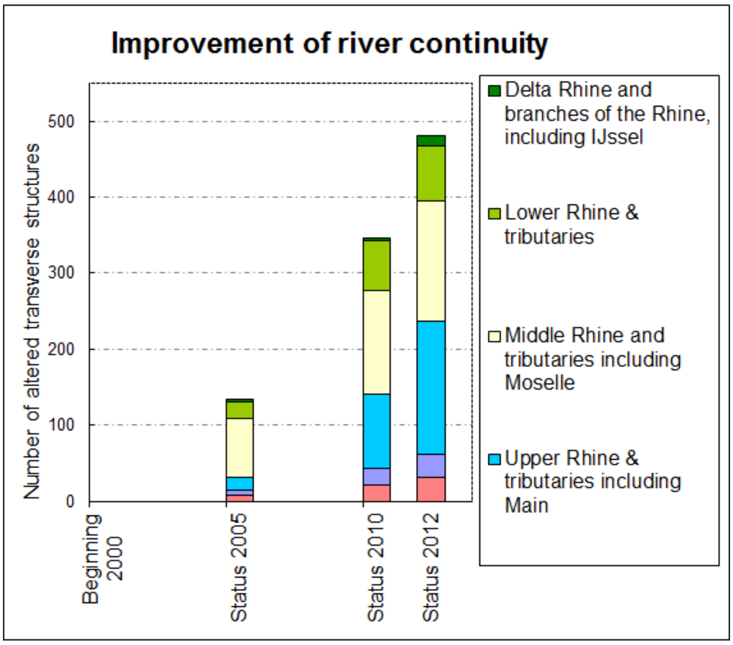

Figure 35: Improved river continuity of the Rhine and its tributaries, in particular of programme waters for migratory fish: Number of altered transverse structures. State June 2013

Following recent mapping, the indications of the ICPR report no. 167 concerning potentially accessible habitat surfaces have been updated. Today, approx. 25 % of the potential salmon spawning habitats in the Rhine system are accessible for salmon (Figure 36).

Due to recent findings in 2013, in the Swiss Aare catchment and in the tributaries of the High Rhine downstream the mouth of River Aare, there are further 200 ha juvenile salmon habitats (included in the uppermost bar of Figure 36) extending the spawning and juvenile fish habitat for salmon in the programme waters in the Rhine catchment to 1200 ha.

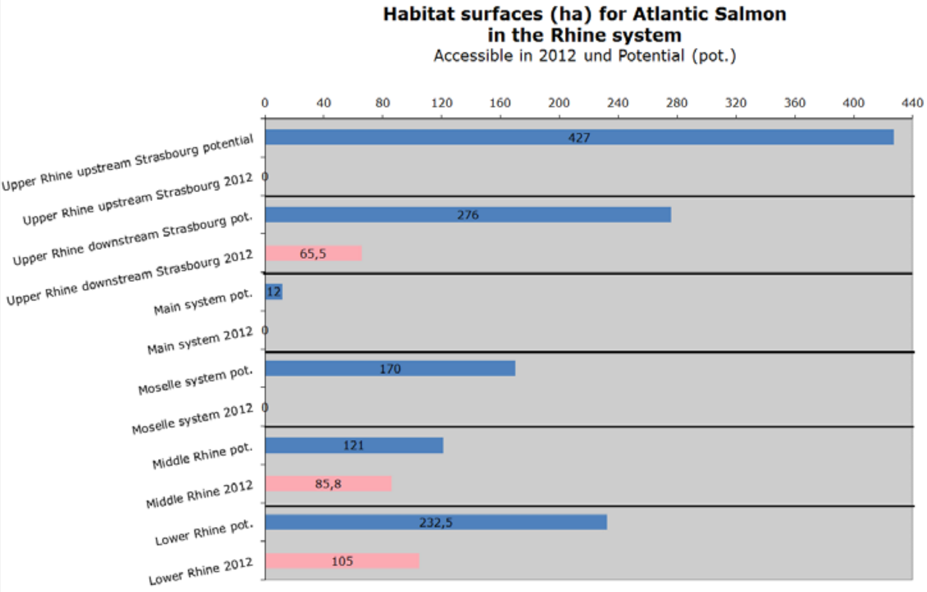

Figure 36: Potential and accessible habitat surfaces for salmon and sea trout in the Rhine system.

As a matter of principle, the restoration of river continuity concerns the **up- and downstream** migration of fish. However, few technical measures are known with respect to the question of how to protect downstream migrating fish at hydropower plants. Therefore, in a first approach, measures aimed at improving upstream migration were first considered for the main stream of the Rhine.

For smaller rivers, including some tributaries of the Rhine, functioning fish protection devices already exist, so that downstream migration through these waters will be included in the Master Plan.

In 2013, the Ministers in charge of the Rhine stated that, for juvenile salmon or adult eel, the downstream migration in the turbine areas is critical because of the great danger of injuries, particularly in cases of successive hydropower plants. They therefore asked the ICPR to intensively work on the joint determination of innovative techniques of downstream migration at transverse structures; their development is required in order to reduce the losses of salmon or eel in the turbines during their downstream migration.

Apart from the inventory of large transverse structures and already existing downstream migration passages (see Map K 8), the Rhine bordering countries are presently discussing activities going on in all states in the Rhine catchment concerning fish protection and downstream fish migration, including the success control and contribute to events on these issues.[62] For 2016 / 2017 an ICPR workshop is planned on best-practice examples to improve downstream fish migration in the programme waters. The results of this workshop will be summarised in a report.

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[62] E.g. see http://forum-fischschutz.de/, http://www.wa21.ch/de/NewsAgenda/Fachtagungen-WA21/2014-Fischwanderung, https://fishpassage.umass.edu/ - Fish Passage 2015

Other measures concerning migratory fish

But there is further need for action apart from the construction of new and the optimisation of existing up- and downstream fish passages in the Rhine.

The **construction of bypasses** and the **near-natural connection of tributaries** are further important measures for migratory fish (see Figure 39).

In the entire Rhine catchment and in the Dutch coastal area, catching and possessing salmon and sea trout is forbidden by law.

Nevertheless, from today's point of view, **fishery** must be considered as a limiting factor for large salmonids and allis shad. Problems remain with respect to implementing the ban on catching and removing salmon and sea trout. For sea lamprey, negative effects can be excluded as this species is of no interest for fishery. Losses of all other migratory fish concern the entire Rhine catchment and the coastal area and are due to mortality during catches, e.g. injuries and stress, to accidental catches (including by-catches) and to poaching. In particular, there are no reliable data on targeted illegal catches. With information campaigns, intensive control measures and the consequent application of criminal law, attempts are made to reduce the rate of salmonid mortality caused by fishery (see ICPR recommendations on the improvement of legal execution to reduce by-catches and forbidden salmon catches by professional and leisure anglers[63]).

Projects and measures for individual migratory fish species

Allis shad

Since 2008 and within an EU LIFE project, comprehensive stocking measures aimed at reintroducing the allis shad into the Rhine system have been implemented in the Upper and Lower Rhine as well as in the River Sieg (NRW). The above-mentioned measures will benefit the allis shad just as much as the other migratory fish species so that, in the medium term, a sustainable re-introduction of this species in the Rhine system may be expected (see Chapter 4.1 Migratory Fish).

Lake Constance Lake Trout

The successful programme aimed at saving Lake Constance lake trout is being co-ordinated by the working group Migratory Fish of the Internationale Bevollmächtigtenkonferenz für die Bodenseefischerei (IBKF) (International Conference of Plenipotentiaries for Fishery in Lake Constance).

The basic report "Habitat for the Lake Constance Lake Trout"[64] commissioned by the IBKF includes a framework programme integrating and coordinating the national programmes of measures aimed at enhancing the Lake Constance lake trout. The common target is to restore and improve the habitat function of the water bodies. The measures the report proposes for the tributaries of the Alpine Rhine will be implemented according to national priorities (see Annex 7). The report is an important basis for international cooperation of the water management authorities in the common catchment (coordination group for implementing the Water Framework Directive in the area of operation Alpine Rhine / Lake Constance). The report points out the particular importance of the continuity of the tributaries to Lake Constance for the Lake Constance lake trout.

Within an Interreg-IV project and on behalf of the IBKF, detailed investigations were carried out along five tributaries of Lake Constance (Bregenzerach, Leiblach, Argen,

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[63] ICPR report no. 167 (2009)

[64] Basic report "Habitat for the Lake Constance Lake Trout" , IBKF 2009

Rotach and Goldach) with respect to their suitability as reproduction and juvenile habitats of the lake trout and with respect to genetic issues. The results of this report[65] have partly already been included into the programmes of measures of the bordering countries and are the basis for the species conservation programme and further fisheries management.

Eel

Contrary to other migratory fish, the eel does not reproduce in fresh water but in the sea (Caribbean Sea, presumably Sargasso Sea). Thus, for this fish species, unhindered downstream migration from the Rhine catchment into the North Sea is particularly important.

For protection purposes and future management of the endangered eel populations in Europe, the EU issued the regulation (EC No. 1100/2007) focussing on a reduction of eel mortality of anthropogenic origin. This regulation lists possible measures aimed at protecting the eel, such as restricting fishery and restoring or improving up- and downstream river continuity. According to this regulation, eel management plans were drafted and reported to the EU Commission by the end of 2008. The environmental objective set by the EC eel regulation is to secure 40 % survival as compared to the natural stock. In June 2014, the OSPAR Commission issued a decision on the conservation of the European eel.

Detailed information on the present risks for the eel and on measures planned in the different states in the Rhine catchment are listed in the Master Plan Migratory Fish Rhine[66] and the report on the national measures according to the EC Eel Regulation in the Rhine catchment 2010-2012[67].

Measures in the different programme waters

Fish migration from the North Sea into the Rhine system mainly occurs at the most important continuous migration route of the **Nieuwe Waterweg** into the River **Waal**. Upstream migration through the locks of the Haringvliet and the Waal is only possible to a limited extent. As of 2018, river continuity in the Netherlands will be improved by the partial opening of the Haringvliet locks by applying a fish-friendly lock regime (costs: 80 million €).

Even though the **IJssel** is of lesser importance (only 1/9 of the discharge of the Rhine), the closure embankment of **Lake IJssel** will also be made easier to pass for fish. In 2015, a fish passage was accomplished near Den Oever. Possibly, the fish passage near Kornwerderzand will be built as a so-called fish migration river. After a successful test phase in 2014, the sluiceways and navigation locks near Den Oever and Kornwerderzand will be managed in a fish-friendly way as of 2015.

Furthermore, and particularly in order to protect the eel, different pumping stations have been / will be fitted with fish protection measures and tributaries will be connected with the main Rhine branches in the delta.

On the **Lower Rhine**, the River **Wupper** tributary and its tributary, River **Dhünn,** and the River **Sieg** with its tributaries River **Agger** and River **Bröl** with more than 200 ha juvenile salmon habitats are of great importance for the reproduction of the migratory fish and for establishing a stable salmon population. A concept for the new phase 2015 to 2020 is being drafted. River Lippe is no programme water; however, migratory fish (stray fish from salmon reintroduction, sea trout and lampreys) occur which means that

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[65] Lake trout - species conservation in the tributaries of Lake Constance, IBKF, 2014

[66] ICPR report no. 179 (2009)

[67] ICPR report no. 207 (2013)

measures aimed at restoring river continuity and at improving spawning habitats are important there too.

The biggest tributaries are along the **Middle Rhine**, River **Moselle** and River **Lahn**. They connect water bodies and their main function is to grant the greatest possible freedom of fish migration to the spawning grounds and juvenile habitats of migratory fish further upstream. Along the River **Moselle**, thanks to the compensating payments for the construction of second lock chambers at 7 barrages between Koblenz and Trier, the continuity of the Moselle (from its confluence with the Rhine) will systematically be improved at all 10 barrages on German territory. In Koblenz, the new fish passage and its visitors' centre "Mosellum" were inaugurated in September 2011 (see Figure 37).

Figure 37: Fish passage and visitor's centre "Mosellum" at the lowermost barrage on the Moselle in Koblenz (photo: Christian von Landwüst)

The modification of the further barrages at Lehmen, Müden, Fankel, St. Adelgund, Enkirch, Zeltingen, Wintrich, Detzem and Trier will, on the long term and in co-operation with Luxemburg, re-open the way towards the habitats in River Sure (70 ha). For further details please refer to the management plan for the Moselle - Saar sub-basin (part B).

In the lower section of the River **Lahn** in Rhineland-Palatinate, nineteen barrages - 4 of which are passable - block the river. The technical solution for river continuity at the Lahnstein barrage is at present being analysed by the Bundesanstalt für Wasserbau with the help of a physical model. Upstream of this section, the river continuity of the Hessian part of the Lahn was successively achieved at seven weirs or drop structures. 51 further transverse structures in the upper Lahn and 32 transverse structures in tributaries suitable for migratory fish will be modified by 2018, resp. 2027 in order to restore river continuity. Within an integrated LIFE project entitled "Living Lahn", the Land Hesse and its project partners (Wasser- und Schifffahrtsverwaltung des Bundes, Rhineland-Palatinate) will be able to work intensively on aspects of ecological enhancement of the River Lahn, including the restoration of river continuity during the years to come.

Further measures have been implemented or are planned for the Middle Rhine tributaries **Ahr, Nette, Saynbach, Wisper** and **Nahe**.

The accessibility of spawning and juvenile habitats in the Hessian tributaries to River **Main** (Schwarzbach/Taunus, Nidda and Kinzig) and to the Bavarian River Main and its tributaries, among other River Sinn and the Fränkische Saale is interrupted by impoundments of River Main. In order to improve this situation, a comprehensive concept has been developed by operators of hydropower plants and the federal Wasser- und Schifffahrtsverwaltung (WSV) in Bavaria based on the "Study of river continuity of the navigable part of the Bavarian Main"[68]. In Hesse, the bypass at the lowermost

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[68] http://www.lfu.bayern.de/wasser/durchgaengigkeit/konzepte_studien/index.htm

barrage on the Main at Kostheim was achieved at the end of 2009, function controls have however pointed out deficits of the upstream and downstream migration passages. Following a request of the approval agency, the operator is planning the construction of a second entrance. The planned modifications of the next barrage on River Main at Eddersheim is a pilot installation of the WSV; work is planned to begin in 2018. Once both of these measures will have been implemented, River Schwarzbach and River Nidda will again be accessible for spawning. Furthermore, the construction of fish passages at two more Hessian barrages on River Main in Offenbach and Mülheim have been agreed (construction work will presumably start by 2021).

The River **Neckar** and its tributaries are neither central migration routes, nor habitats for anadromous fish species. However, when planning and implementing measures, long distance anadromous migratory fish species such as allis shad and the eel as a catadromous migratory fish species will be taken into account. Creating a network of spawning and juvenile habitats is of particular importance for the development of the fish fauna, above all in the 208 km long navigable section of River Neckar between Mannheim and Plochingen. The federal authorities have drafted a concept for action and priorities for restoring river continuity along federal waterways which equally includes the 27 barrages in the federal waterway Neckar. Apart from restoring the ecological continuity of the entire navigable River Neckar, measures aimed at creating habitats for species living in the river are to be carried out in the sections of the old Neckar. These sections present the best potential for the river fauna. Thus, sufficient water feeding is crucial. The structurally impoverished surrounding sections of the Neckar can only be re-colonised from these locations. Furthermore, for species living in standing waters and species without specific requirements, measures must be taken to create habitats in side waters connected only at one end and thus without flow (replacement structures for floodplains) or in parallel channels resp. riverbank structures protected against the lapping of waves. The lowermost transverse structure at Ladenburg has already been equipped with a fish passage. Today, the planning procedure for two fish passages located at Kochendorf and Lauffen is going on (begin of construction presumably before 2021). Furthermore, the upstream fish passages located at the weir/hydropower plant Wieblingen, the lock/hydropower plant Horkheim and Gundelsheim are in their planning phase.

Other important tributaries of the Upper Rhine are River **Wieslauter, Murg, Ill** with its tributary **Bruche**, Rivers **Alb, Rench, Kinzig** and River **Elz** with its tributary Dreisam.

On the **southern Upper Rhine,** barrages interrupt the continuity of the Rhine. A fish passage was put into operation at the downstream barrage at Iffezheim in 2000 and at Gambsheim in 2006. As a consequence, upstream tributaries of the Rhine, the water systems of the French Ill and of River Kinzig in Baden-Württemberg are again accessible.

Between 2009 and 2013, a 5th turbine has been mounted in the hydropower plant **Iffezheim**. This installation led to distinct restrictions for the fish passage during the period in question (see Figure 21 and Table 8). The fish passage at the Iffezheim barrage will be optimised in 2016.

A study carried out during 2003-2006 examined the **feasibility** of the “Restoration of the ecological continuity of the Upper Rhine for the fish fauna"[69] as far as the Basel area.

In order to make the **Elz-Dreisam** area on the Upper Rhine accessible, fish passages must be built both at the Strasbourg and at the Gerstheim barrage. The fish passage **Strasbourg** will start operating in 2015. Construction work on the fish passage in **Gerstheim** will begin in the fall of 2015, the fish passage will presumably be functioning in 2017.

Furthermore, at several **agricultural weirs** in the **loops** at **Gerstheim** and **Rhinau**, which are operated by the French state, river continuity must be restored by the same dates. As they concern French as well as German territory, measures aimed at

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[69] ICPR report no. 158 (2006)

surmounting the agricultural weirs in the Gerstheim and Rhinau loops will be co-ordinated on a bilateral basis.

These measures will open a further section for river continuity into the tributaries and towards Basel. The total costs for this section are estimated to approx. 39 million €.

When the afore-mentioned measures will have been achieved, upstream migration into the Elz-Dreisam catchment area with its 59 ha of spawning and juvenile habitat will be possible. Until 2015, river continuity in this catchment will be restored along 90 km, and until 2027 along 109 km (total expenses: 25.8 million €).

Securing upstream and downstream river continuity at **Vogelgrün** in the old bed of the Rhine is a prerequisite for the planned re-colonisation of the upstream migratory fish programme waters along the High Rhine in the Basel area and in the tributaries of R. Aare, where salmon habitats have been mapped. Such a measure will contribute to build migratory fish populations in the old bed of the Rhine. The situation is complex, among others because a navigation channel and an island in the Rhine with a hillock are located between the entrance for upstream migrating fish at the Vogelgrün barrage and the further migration corridor of the old bed of the Rhine which is considered to be a priority migration corridor. Following a mandate of the Conference of Ministers, an exchange of experience between experts was arranged on 23 September 2014. The target was to contribute to finding a technically optimal solution for transferring fish from the tailwater of the hydropower plant at the Vogelgrün barrage into the old bed of the Rhine. The result is that two possible solutions and the conditions for the entrance and the attraction flow at the barrages Rhinau, Marckolsheim and Vogelgrün presenting the same hydraulic situation in the tailwater will now be analysed more thoroughly.

On behalf of the ICPR, the project group Oberrhein / Rhin Supérieur (PG ORS) which was established mid of 2015 will follow the implementation planning for an efficient fish passage system at the barrages on the Upper Rhine located at Rhinau, Marckolsheim and Vogelgrün as a platform for information and discussion and fulfil an advice function for EDF as developer and will evaluate the results.

During 2015 - 2018, the PG ORS will follow the feasibility studies for solution options for the entrance for fish and the routing of the fish passage at the Vogelgrün barrage and for classical fish passages at the barrages Rhinau and Marckolsheim. During 2017-2018/19 the PG ORS will follow the pre-projects for these 3 fish passages (i.e. until just before authorisations are granted and ground-breaking). Furthermore, planning and construction of several smaller measures aimed at river continuity and optimisation will be followed until 2020.

At the **agricultural weirs Kehl and Breisach**, fish protection and downstream fish migration passages were built as part of the construction of small hydropower plants and the operability of the existing fish passages has been improved. The entrance of the fish passage at the agricultural weir Breisach is still to be optimised.

The new concession for the **Kembs** power plant includes the obligation to construct a new fish passage at the discharge power station and to increase the minimum discharge into the old bed of the Rhine. The French concession provides for increased residual flow with seasonal variations. The basic flow from November to March has been fixed at 52 m^3/s (Decree No. 2009-721 dated 17 June 2009). The concession includes a review clause with respect to a possible increase of the residual flow as of 2020. The concession was granted in 2010, and the new minimum discharge into the old bed of the Rhine applies since then.

Along the High Rhine, in the Basel area, the continuity of the water systems of **Wiese, Birs** and **Ergolz** is being improved (see Annex 7).

On the **High Rhine,** the power plants at Birsfelden, Augst-Wyhlen, Rheinfelden, Ryburg-Schwörstadt, Bad Säckingen, Laufenburg, Albruck-Dogern, Eglisau, Reckingen and Schaffhausen are equipped with fish passages. River continuity for fish migration has been or will be considerably improved at several hydroelectric plants on the Rhine between Basel and the mouth of River Aare and everywhere at least two well-functioning possibilities for upstream migration will be created: The second technical fish passage at the weir of the Rheinfelden power plant was put into service in 2010 and the large bypass has been constructed. In 2014, a new bypass was constructed at the Ryburg-Schwörstadt power plant and the existing technical fish passage was improved. Furthermore, bank structures were improved for the fish fauna. The new bypass at the Albbruck-Dogern power plant was put into service at the end of 2009 and, here too, the existing technical fish passage has been completely renewed and optimised. A new concession has been granted for Eglisau and the construction of a fish passage and a fish lift will be achieved during 2016. The cantons presented restoration plans with respect to fish migration for all power plants to the state by end 2014. According to the Swiss law on water protection, the rehabilitation of all passages due for rehabilitation must be achieved by 2030 at latest, for hydropower plants on the borders the consent of the neighbouring country concerned is required. The hydropower plants on the High Rhine are of utmost priority. As far as the Swiss share of the territory is concerned, rehabilitation with a view to restoring river continuity is entirely covered.

On 11 December 2009, the Swiss parliament accepted a counterproposal to the popular initiative “Living Water”, aimed at accelerated renaturation of brooks and rivers, and filed by the Commission for Environment, Spatial Planning and Energy of the Council of States. The required modifications of laws have been adopted, to enhance the revitalisation of waters, to reduce the negative impact of discharge fluctuations downstream of power stations with reservoirs, to reactivate the bed-load balance and to restore fish migration at power plants. At the same time, the basis was created to secure the financing of measures. The following approach is planned in order to implement this regulation:

- The Cantons plan the revitalisation of waters and implement the corresponding measures according to their priorities.
- The Cantons plan restoration measures in the fields of hydropeaking, bedload balance and fish migration and presented their plans to the federal government by the end of 2014.
- The operators concerned will implement these measures according to the schedule of the canton and at latest 20 years after the new regulations entered into force.

Today, the 142 km of High Rhine are impounded by 11 barrages along a section of hardly 100 km between Lake Constance and Basel. This circumstance and lacking influx of bedload from the tributaries have considerably reduced the bedload discharge in the river and strongly limited the habitat of fish and small animals. In particular, the species of the original habitat are threatened. The Master Plan “Measures aimed at Reactivating Bedload in the High Rhine”[70] commissioned by the Swiss Federal Agency for Energy and the Regierungspräsidium Freiburg indicates, how the bedload transport can be reactivated and how river sections can be ecologically improved. According to Swiss law, the hydropower plants are obliged to remove major impairments of the bedload balance. The measures described in the Master Plan meet the requirements according to Swiss law.

With several 10,000 m³ of bedload influx annually, the rivers Thur, Töss and Aare used to be the most important contributors of bedload for the Rhine. The construction of hydropower plants along the Rhine and River Aare beginning around 1900 and structures in the tributaries have increasingly limited the influx of bedload into the Rhine and the transport capacity. The now existing 11 barrages reduce or impede the bedload transport capacity. Natural or near-natural flow conditions are found in the four freely flowing sections after the outlet of Lake Constance before the Falls of the Rhine, before the mouth of River Thur and between the hydropower plant Reckingen and the mouth of River Aare, as well as in the head of reservoir areas of some power plants. Along these sections, there is little or no influence on the bedload transport capacity.

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[70] Master Plan “Measures aimed at reactivating bedload in the High Rhine”

Due to the reservoir area of a hydropower plant, the influx of bedload from River Thur and River Töss is cut off and, in the Klingnauer Stausee, the bedload from River Aare is retained. That means that the originally dominant influx of bedload have been cut off from the High Rhine. Among the sections with natural or near-natural discharge conditions and bedload transport capacity, only a short section between Wutach and the hydropower plant Albbrug-Dogern is fed with bedload from River Wutach.

The Master Plan shows, in which river sections the habitat for fish and small animals can be improved (see Figure 38). In particular the freely flowing river sections give evidence of a great bedload deficit and a great potential for ecological upgrading. The river sections concerned are those between the Reckingen hydropower plant and the Albbruck-Dogern hydropower plant (Koblenzer Lauffen), the section of the residual flow at the Albbruck-Dogern hydropower plant and the sections downstream of the hydropower plants Säckingen and Rheinfelden. However, a reactivation of the bedload in the impoundment areas of hydropower plants does not lead to any considerable improvement for fish species spawning on gravel or for small animals living in the gravel.

The Master Plan makes precise proposals how to reactivate the bedload transport in sections with potential for ecological upgrading. These measures include artificial adding of gravel, permitting lateral erosion, filling up bedload traps and temporary lowering of the water table at hydropower plants in order to permit bedload transport in impoundments.

For at least 10 locations upstream the inflow of River Aare it has been recommended to add gravel. The planned annual supplementation amounts to some 9000 m^3, since 2013, almost 20,000 m^3 have been supplemented.

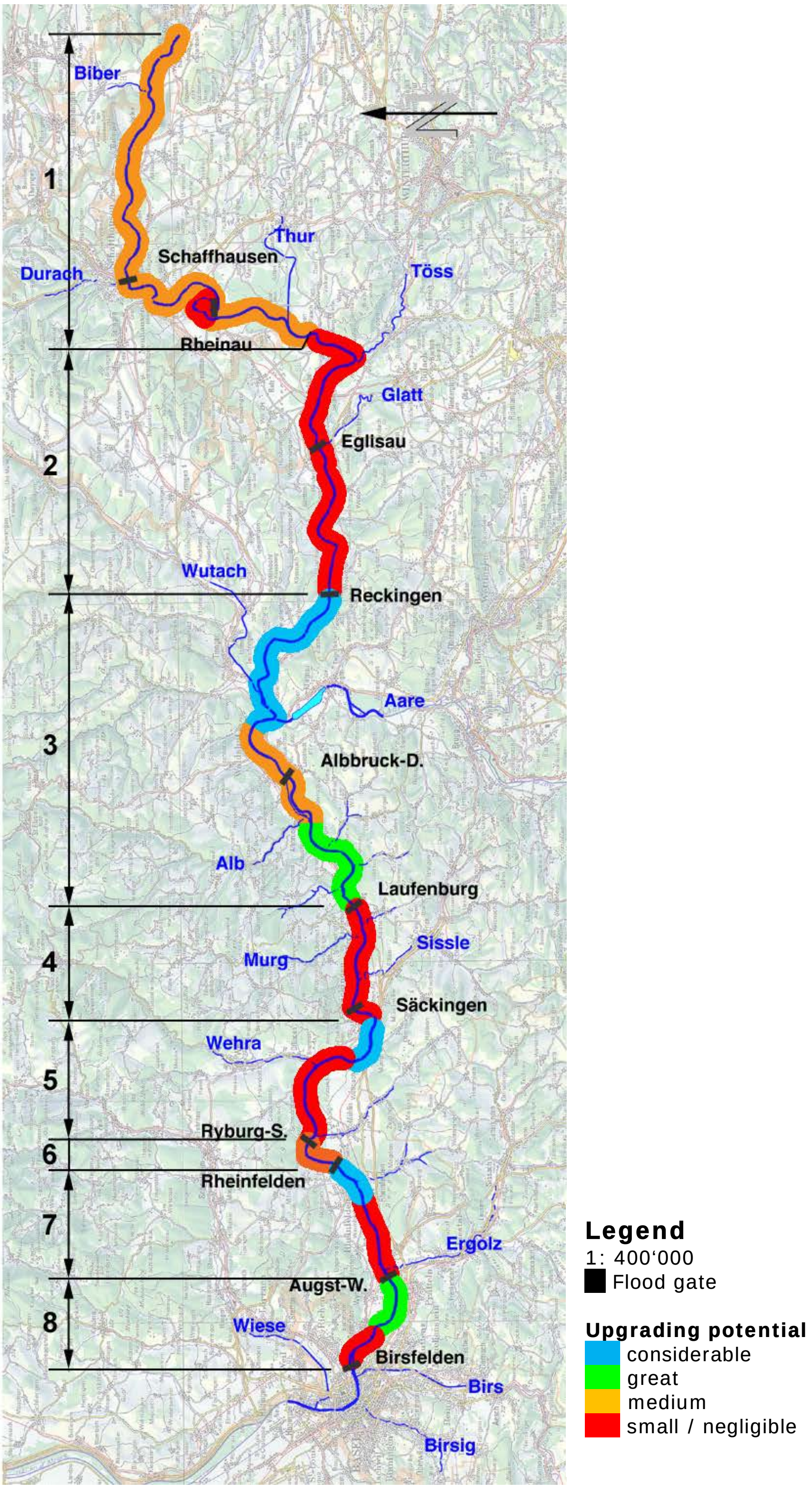

Figure 38: Upgrading potential with respect to the bedload balance, taking into account existing power plants.

Several measures aimed at improving river ecology have been implemented in the **Alpine Rhine / Lake Constance** sub-basin. The focal points for improving the ecological status/potential of rivers include measures:

- to improve river continuity for fish; in this connection, the Lake Constance lake trout is publicly perceived as an important "symbol species" in the catchment of the Alpine Rhine/Lake Constance;

- to improve the water regime in river sections impacted by diversions (residual flow) or discharges (hydro-peaking);
- to improve river morphology and widening the watercourse corridor.

For the lake trout, the continuity of the **Alpine Rhine** is provided from the outlet into Lake Constance at river kilometre 94 to the confluence of the Posterior Rhine and the Anterior Rhine at river kilometre 0. The river bed sills at Buchs (river-km 49.6) and Ellhorn (river-km 33.9) are passable for the lake trout but constitute artificial limits of distribution for other fish species. In 2000, a technical fish passage was constructed at the Reichenau power plant (river-km 7). Permanent monitoring proved that this plant does not obstruct upstream migration of the sea trout.

Increasing habitat diversity

The species diversity of a river mainly depends on the diversity of its morphological structures. Therefore, above all, structural diversity in the river bed and along its banks must be increased and waterway maintenance must be environmentally compatible. When classifying the ecological status/potential according to WFD, hydromorphology is a supporting quality element.

These measures will contribute towards opening up further habitats for the flora and fauna living in the water, on its banks and in the floodplains.

Within the framework of the Rhine 2020[71] programme, 100 oxbow lakes and backwaters will, for example, be reconnected with the dynamics of the Rhine by 2020, and former hydraulic and biologically effective connections between the river and its floodplains will be restored.

Along suitable sections of the Rhine, the structural bank diversity should be increased along 800 km at a minimum, taking into account aspects of security and efficiency for navigation and the safety of people.

Additionally, further hydromorphological processes will again be made possible on the French bank (controlled erosion at two locations). An INTERREG project, in which technical institutes from Alsace (F) and Baden-Württemberg (D) participated, was concluded in 2012 (influx of bedload due to controlled gravel input). A plan must be drafted for the influx of bedload (use of the excavation from the new hydropower plant in Kembs). On the German bank, measures aimed at flood protection are planned which, during the years to come, will sustainably improve the ecological quality of water and floodplain habitats in this important river section between Kembs and Breisach (50 km). These measures are expected to considerably enhance the entire ecosystem of the old bed of the Rhine (among others: reactivation of 88 ha of spawning and juvenile habitats).

Figure 39 gives a survey over measures implemented during 2000 to end 2012 aimed at reconnecting oxbow lakes (left) and at improving the structure of the banks of the Rhine (right).

Figure 40 is an example of the improvement of the riverbank structure of the Rhine before and after upgrading measures.

Until 2021, many different measures will be implemented, in particular to increase habitat diversity in the stream channel and its surroundings. The same is true of measures along the great navigable tributaries, Moselle, Main and Neckar, and of the River Lippe. These measures aim at achieving the “good ecological status” for natural waters or the good ecological potential for heavily modified waters. Similar measures will also be part of the management plans within the 3rd cycle, as not everything will have been implemented by 2021.

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[71] ICPR documents Rhine 2020

In order to improve the bedload balance and to reduce streambed erosion, bedload is added in many places or sediment material is transferred into sections lacking bedload.

Due to the intensive use of the main stream of the Rhine as shipping lane and to the density of settlements of most riverbank areas, natural lateral erosion which would enable natural bedload transfer is only possible along certain sections. These river sections should be identified in the different states and it should be examined, where lateral erosion might again be accepted or enhanced without impacting navigation.

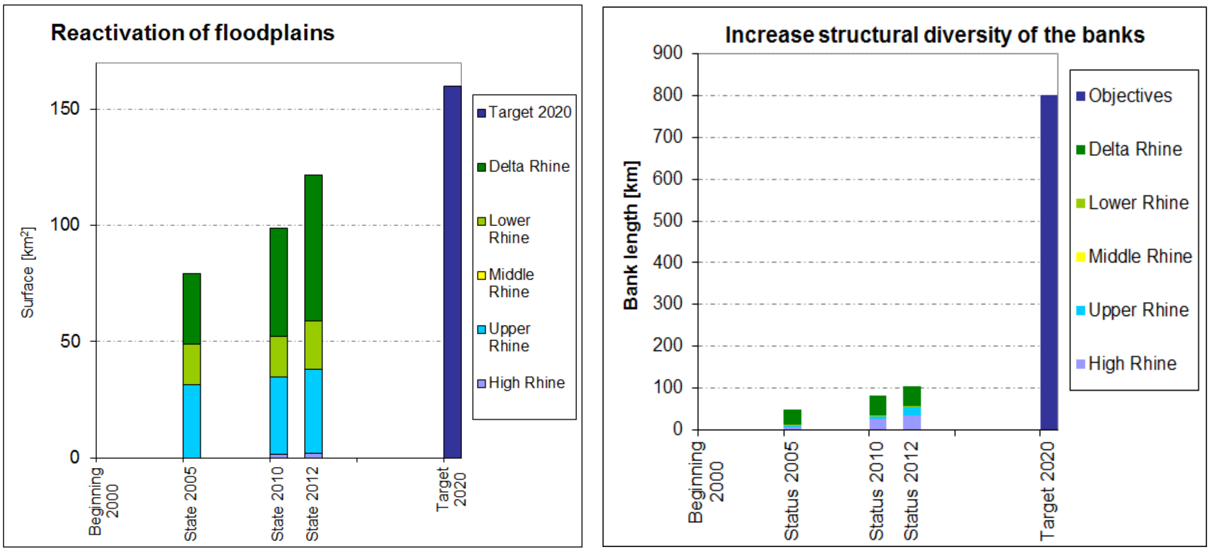

Figure 39: Number of floodplain waters reconnected with the Rhine (left) and length of river banks along the main stream of the Rhine, where measures aimed at structural improvement were implemented

Figure 40: Bank of the Rhine before (left) and after (right) structural improvements - from reinforced banks towards flat river banks (photos: Angelika Halbig, BCE; Ernst-Dieter Kuczera, SGD Nord).

Measures aimed at increasing habitat diversity in the riverbank area are:

a) Dismantling of riverbank stabilisations in places, where these are not required for safety or maintenance reasons. Since the invasive gobies above all benefit from riverbank structures with riprap structures, the partial removal of riverbank stabilisations which are no longer strictly required (e.g. at sloping banks) is an effective measure to counterbalance the further spreading of these fish species. Improvement of the access to the water body, also with simple measures; create foreshores in impounded sections wherever possible;

b) Optimisation of river constructions, greater ecological design of the groynes, parallel diversion structures where this is spatially possible;

c) Protection from the lapping of waves, e.g. due to parallel structures, bypasses or partially closed groynes gradually filling up. These areas may develop shallow replacement habitats and juvenile habitats protected against the lapping of waves in the river itself which, among others, benefit juvenile fish, water plants and invertebrates. From there, areas presenting deficits may be re-colonised by many species; include problems posed by hydropeaking;

d) Increasing runoff diversity;

e) Revitalisation of spawning and juvenile habitats.

Measures aimed at increasing habitat diversity in the riverbank area and floodplains are:

a) Improvement of the lateral cross-linking with the aquatic environment, where possible by creating and connecting secondary tributaries (with sufficient flow and varying flow velocity) in order to optimize the stepping stone function of the river bank and the aquatic surroundings in the network of biotopes and to open up side waters rich in aquatic plants, terraced scouring waters, impounded alluvial waters, alluvial zones with flow through and standing waters and by-passes as habitats for fish, invertebrates and aquatic plants;

b) Enhancement of near-natural connections of tributaries in the Rhine estuary;

c) Where possible, integration of dike relocations into the extension of alluvial areas when planning measures (also makes sense for reasons of flood protection);

d) Enhancement of near-natural vegetation in the alluvial area, creation of riverbank strips, above all below sloping surfaces without vegetation (fields, etc.); enhancement of environmentally compatible agriculture and extensive agriculture to reduce inputs of fine sediments and of nutrients and pesticides of diffuse origin.

These proposals indicate general possibilities for the implementation of measures aimed at enhancing habitat diversity. Many of these measures are part of national programmes of measures. Therefore, further details are included in Parts B of this international management plan for the IRBD Rhine (Part A).

In future, the implementation of the different ecological measures and continued intensive, coordinated biological monitoring will make it possible to observe long-standing trends and developments on the basis of robust data. This is in particular valuable with respect to climate change.

Figure 41: River Ruhr near Wickede 2013 before (left) and 2014 after (right) renaturation. Photo: MKULNV NRW

Figure **42**: River Ruhr near Arnsberg; in the foreground a renatured section, in the background a not renatured section. Photo: G. Bockwinkel, MKULNV NRW

Flood protection

In 1998 and following the great floods of the lower sections of the Rhine in 1993 and 1995, the Rhine bordering countries estimated the financial means for implementing the Action Plan on Floods to 12.3 billion €. By the end of 2010, more than 10 billion € had already been spent for flood prevention measures including the creation of flood retention areas. By 2020, flood retention areas will be available for some 361 million m^3, by 2030 for some 540 million m^3. Partly, these measures are linked with reactivating and thus increasing floodplains, as is shown in Figure 43.

In future, the implementation of the EC directive on Flood Risk Management (2007/60/EC) will have a decisive influence on flood prevention in the IRBD Rhine. Therefore, please refer to the Flood Risk Management Plan for the IRBD Rhine to be drafted by 22 December 2015. With respect to measures, the Directive equally provides for an interlinking with the WFD (see Figure 43). This must above all be pointed out in the Flood Risk Management Plans.

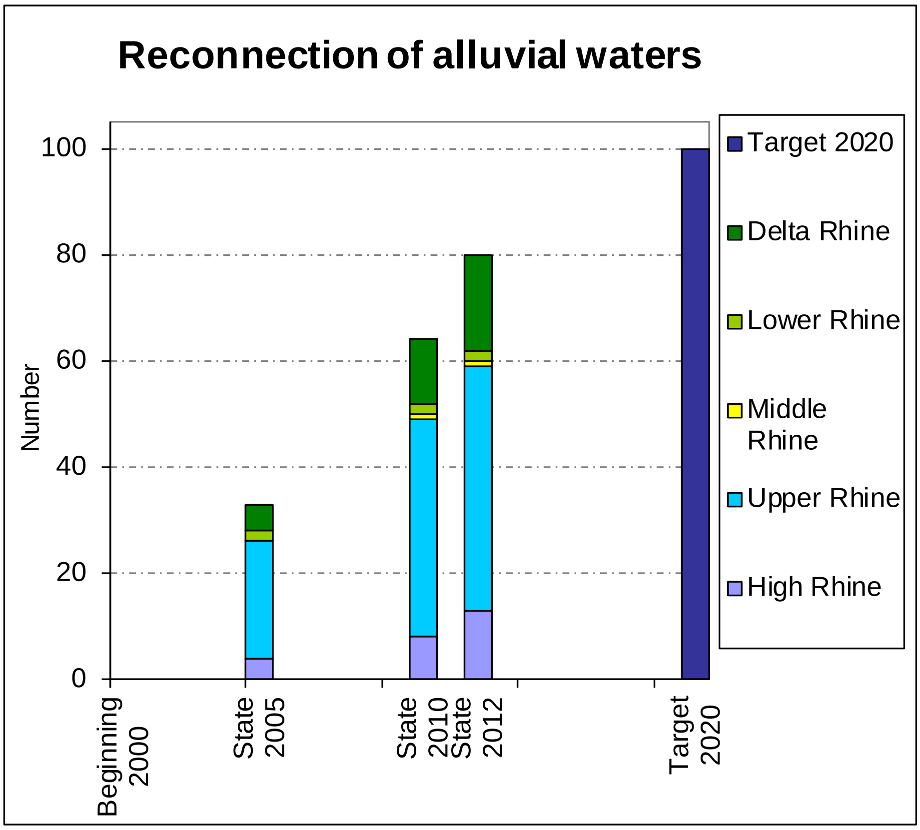

Figure 43: Reactivation of floodplains between 2000 and 2012

7.1.2 Reduction of diffuse inputs impacting surface water and groundwater (nutrients, pesticides, metals, noxious substances from historic pollution and others) and further reduction of pollution of industrial and municipal origin

Following the decreasing number of point sources among the total emissions into waters, the share of diffuse inputs increases so that these today represent the major part of water pollution. The further analyses of possible measures aimed at reducing emissions into water bodies must not only take into account input paths, but also their sources. As the relevance of substance inputs has changed, the improvement of water quality must not only imply the states, but often also other actors, such as EU or worldwide bodies.

Physico-chemical elements

The EC Directives 91/676/EEC (nitrates directive), 91/271/EEC (urban waste water directive) and, to a lesser degree, Directive 2010/75/EG (IPPC directive on industrial emissions) are important instruments for the further reduction and avoidance of **nutrient emissions** into water bodies. Furthermore, during the past decades, the implementation of additional political programmes, such as the Rhine Action Programme and the considerable investments associated with its implementation as well as OSPAR recommendations were of great importance. These programmes contributed to a distinct reduction of phosphorus and nitrogen concentrations in the entire catchment area during the past two decades.

The states, respectively federal states/regions in the IRBD Rhine will continue to implement the measures already taken to reduce the nitrogen load, taking into account the polluter-pays principle as well as applicable EU legislation, previous achievements and aspects of appropriateness. It is moreover assumed that the countries bordering the North Sea in charge of other catchments pouring into the North Sea will make equivalent reduction contributions.

Within the implementation of the nitrates directive, the EU Member States of the IRBD Rhine have drafted nitrate action programmes. Apart from adapting fertilisation standards, further measures are to be implemented or planned, such as:

- Good agricultural practice which may include information on and introduction of certification systems.
- Prohibition of fertiliser distribution in autumn or winter or on water-saturated or frozen soil or soil covered with snow;
- Keeping bank areas free of fertiliser or cultivation;
- Prohibition of ploughing grassland;
- Cultivation of swamp areas and helophyte fields;
- Extensification of livestock breeding;
- Improvement of the rate of implementation and fertilisation;
- Advisory services aimed at further improving the efficiency of fertilisation and land utilisation, e.g. information on nutrient accounting procedures and planning of fertilisation;
- Enhance agri-environmental measures, e.g. winter greening with intercropping and undersowing of arable areas aimed at reducing the nitrogen contents of the soil in autumn;
- Enhance investment in order to create additional storage capacity for farm manure.

Additionally, specific programmes are targeted for further reduction of nitrogen emissions. Furthermore, different regulations apply to water conservation areas protecting drinking water supplies against inputs of nitrate and other substances such as pesticides. The intention is to tighten up these regulations in the most polluted drinking water abstraction areas in certain parts of the catchment. The European “Common Agricultural Policy (GAP)” refers to the close connections between agriculture and water management. In 2014, the new GAP guidelines were adopted for the period until 2020; they comprise the protection targets of the WFD.

As far as emissions from wastewater treatment plants are concerned, reduction measures taken since 2000 have continued to be successful. Existing concepts for wastewater elimination are often at the basis of further measures, such as optimising the operation of wastewater treatment plants. Other measures are e.g. new sites for wastewater treatment plants or transfer/deviation of wastewater flow and/or merging wastewater treatment plants.

Considering the fact that only a small percentage of nutrient inputs is of industrial origin, no further significant improvement of the Rhine water quality is to be expected from measures aimed at a further reduction of direct inputs from industry.

Reduction measures taken during the past 30 years have reduced the total nitrogen load discharged from the river area into the coastal waters by about 40 % (see Chapter 4.1.1). However, in particular in agriculture, reduction measures must be increased in order to achieve a stable good status of all water bodies.

Table 12 shows the nitrogen emissions as a sum for national catchment areas, and differentiated according to input pathways (urban, industrial, agriculture). Emissions in 2000, those included in the Management Plan 2009, in 2010, 2014 and as indicative prognosis for 2021 are compared.

Since 2000, the calculated nitrogen emissions have dropped by about 15 %. The real reduction will presumably be higher, as the calculations at hand of the diffuse nitrogen discharges include natural background contamination. This was not the case during earlier calculations (see Table 12). On the whole, a further 5 % reduction is expected for 2021.

Table 12: Nitrogen emissions from agriculture, wastewater treatment plants and industry in the river basin district Rhine and prognosis for 2021 (kilotons/year)

Country	**Emission 2000** **(in kt)**	**Emission according to 1st Management Plan** **(in kt)**	**Emission 2010** **(in kt)**	**Emission today (2014)** **(in kt)**	**Prognosis 2021** **(in kt)**
Agriculture (as well as all diffuse inputs of anthropogenic origin)**					
AT	2	2	2.0	2.0	2.0
LI	n. s.	-	n. s.	n. s.	n. s.
CH[72]	12 (2001)	11 (2005)	13.0	16.5	15.0
DE[73]	113	113	145	140 (2011)	133.5
FR	23	14 (2006)	3.7	3.7	3.7*
LU	3.7	3.1	2.7	2.4 (2011)	2.4*
BE/Wallonia	n. s.	1.18	1.6	1.6	1.6*
NL[74]	42	34 (2006)	35.2	34.2 (2013)	33.8
Rhine catchment area	> 196	> 178	203	200	192
Wastewater treatment plants (including diffuse urban)					
AT	0.8	0.6	0.5	0.5	0.4
LI	n. s.	0.06716	n. s.	n. s.	n. s.
CH	13 (12+1)	12(11+1) (2005)	9.4	9.4	10.0
DE	72 (63+9)	60	47.0	47.0 (2011)	47.0
FR	18 (15+3)	4 (2006)	7.2	7.2	7.2*
LU	1.8	1.7	1.6	1.4 (2011)	1.4*
BE/Wallonia	n. s.	0.06	0.1	0.1	0.1*
NL	22 (20+2)	15 (2006)	12.5	11.0 (2013)	9.5
Rhine catchment area	> 128	> 93	78.3	76.5	75.6
Industry					
AT	n. s.	0	0.2	n. s.	n. s.
LI	n. s.	-	0.0	n. s.	n. s.
CH	1	1 (2005)	1.3	1.3	1.0
DE	15	15	9.1	9.1	9.1
FR	5	5 (2005)	2.8	2.8	2.8*
LU	0.007	0.003	0.002	0.001	0.001*
BE/Wallonia	n. s.	0.06	0.0	0.0	0.0*
NL	3	2 (2006)	1.6	1.5 (2013)	1.5
Rhine catchment area	> 24	> 23	15.0	14.8	14.5
Total IRBD Rhine	**> 348**	**> 294**	**296.4**	**291.6**	**282.0**

n.s. Not specified

* If no prognosis was available for 2021, data of 2014 were used.

** As of 2010 including natural background contamination

Today, values exceeding national assessment standards for phosphorus are still stated at many monitoring stations (s. Chapter 4.1.1 and Annex 2).

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[72] Switzerland: Calculations with revised model (2014), increase of emissions of agricultural origin due to model adaptations (including background contamination); all indications for Switzerland concern the Rhine catchment below the lakes

[73] The calculation of German discharges of agricultural origin include erosion with 93 %.

[74] Netherlands: Indications without atmospheric deposition (about 9 kt)

Table 13 shows the phosphorus emissions as a sum according to national catchment areas, and differentiated according to input pathways (municipal, industrial, agriculture). Emissions in 2000, 2010, 2014 and as indicative prognosis for 2021 are compared. Generally, a further 5 % reduction of phosphorus emissions is assumed.

Table 13: Phosphorus emissions from agriculture, wastewater treatment plants and industry in the river basin district Rhine and prognosis for 2021 (tons/year)

Country	**Emission 2000** (in t)	**Emission 2010** (in t)	**Emission today (2014)** (in t)	**Prognosis 2021** (in t)
Agriculture (as well as all diffuse inputs of anthropogenic origin)				
AT	n. s.	17.5[c]	17.5*	17.5*
LI	n. s.	n. s.	n. s.	n. s.
CH**	272[a]	368	368	368
DE	5,070[a]	4,810[d]	4,749[d] (2011)	4,749*
FR	840[a]	780 (2012)	780 (2012)	740
LU	n. s.	n. s.	n. s.	n. s.
BE/Wallonia	n. s.	33.6	29.60 (2015)	29.60
NL	3,930	2,946	2,900 (2013)	2,872
Rhine catchment area	10,112	8,955	8,844	8,776
Wastewater treatment plants (including diffuse urban)				
AT	n. s.	75[c]	75*	75*
LI	n. s.	3	3	3
CH**	<1,072[b]	<1,062	519	519
DE	5,585[b]	5,549	5,489 (2011)	5,489*
FR	<3,451[b]	2,565 (2012)	2,565 (2012)	2,400
LU	n. s.	n. s.	n. s.	n. s.
BE/Wallonia	n. s.	11.6	11.7 (2015)	11.2
NL	2,045[b]	1,629	1,514 (2013)	1,075
Rhine catchment area	12,153	8,330	7,612	7,172
Industry				
AT	n. s.	9.5[c]	9.5*	9.5*
LI	n. s.	0	0	0
CH**	<20	<20	<20	<20
DE	433	274	269 (2011)	269*
FR	<536	490 (2012)	490 (2012)	450
LU	n. s.	n. s.	n. s.	n. s.
BE/Wallonia	n. s.	0.8	1.9 (2015)	1.9
NL	1,434	158	154 (2013)	154
Rhine catchment area	2,423	952	944	904
Total IRBD Rhine	**24,688**	**18,237**	**17,400**	**16,853**

n. s. Not specified

* If no data were available, the data from previous years were used.

** All data for Switzerland concern the Rhine catchment downstream the lakes

[a] Data from report no. 134: Sum of farm effluents, drift, erosion, surface runoff, drainage and groundwater.

[b] Data from report no. 134: Sum of point sources and diffuse sources of municipal origin

[c] Data from STOBIMO, UBA/TU-Wien/BMLFUW, 2011; the total P emissions into Austrian surface waters in the Rhine catchment including among others atmospheric deposition, erosion from natural surfaces and snow melt amounted to 122 tons per year.

[d] The German discharges from agriculture and all anthropogenic diffuse discharges are determined without taking into account atmospheric deposition.

With respect to the reduction of thermal pollution of the Rhine please refer to activities within climate protection (s. Chapter 2.4) and to measures already taken within phasing out nuclear energy in Germany which also contribute to reducing the thermal load of the Rhine (see Figure 9).

Substances relevant for the Rhine

Monitoring results show (see Annex 2) that **zinc, copper and PCB** as substances relevant for the Rhine[75] continue to pose a problem. Furthermore, national EQS for **dimethoate** in River Schwarzbach (Main), **dichlorvos** in River Erft, **arsenic** in River Kinzig and Erft and, on the Wadden coast, **chromium** were exceeded.

With a view to fighting inputs of these substances, measures must be taken at the source for **zinc** and **copper**, in particular, since wastewater treatment plants were not designed to eliminate heavy metals from wastewater. No obvious measures can be recommended for rehabilitation purposes. Alternatives for the use of copper and zinc are being looked into in different sectors.

In agriculture, copper is used as a disinfectant for the hoofs of dairy cattle. Often, residues of the so-called copper baths are mixed with manure. Different possibilities of reducing the copper emissions are being looked into.

In agriculture, harmonised EU standards apply to the maximum application of these metals in fodder (fertiliser and fodder containing copper). The assessment of additives must take into account the impact of these substances on the soil and waters to a greater extent.

On the whole, the available operational measures for reducing the diffuse inputs of copper and zinc at the source have already been taken or started.

PCBs are today worldwide spread in the environment and mainly originate from earlier applications. They are re-distributed between the individual environmental compartments due to remobilisation processes. Transport is mainly by the atmosphere. The major share of PCBs in the atmosphere is due to volatilisation from the soils which, together with sediments in water bodies, are the main sink for PCBs. PCB, just as HCB, may negatively impact sediment quality. All measures to reduce emissions have been taken, no direct PCB discharges are known. As far as possible, heavily polluted water sediments must be cleaned up. As releases from water body sediments continue, achievement of the objective does not appear to be inherent.

Apart from the pollution of water bodies, the pollution of biota with PCBs is relevant for taking measures. Comprehensive data on the pollution of fish with PCBs and other pollutants are available in the IRBD Rhine and have been compiled in a report.[76] In 2014/2015, the ICPR conducted a pilot programme on the monitoring of the contamination of fish[77]. The data available by 2016 will be analysed and published in a technical report.

The measures concerning the substances relevant for the Rhine arsenic, chromium, dichlorvos and dimethoate will not be discussed in detail here. For further information, please refer to the Part B reports.

Priority (dangerous) substances and certain other substances

In the IRBD Rhine, some of the 41 priority substances and certain other pollutants listed in the Directive 2008/105/EC in the version of the Directive 2013/39/EU are problematic:

- Brominated diphenyl ethers (PBDE)
- Hexachlorobenzene (HCB)

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[75] ICPR report no. 215 (2014)
[76] ICPR report no. 195 (2011)
[77] ICPR report no. 216 (2014)

- Hexachlorbutadiene
- Isoproturon
- Nickel
- Polycyclic aromatic hydrocarbons (PAH)
- Mercury
- Tributyl-tin compounds (TBT)

In the entire EU, PBDE, mercury, certain PAH-compounds and TBT are classified as **ubiquitous**. Generally speaking, there are few appropriate measures for reducing the pollution with these substances on the short or medium term.

PAH compounds: PAH concentrations today determined in water bodies are not directly bound to a local source of emission but are, above all, caused by diffuse emissions from combustion plants and motors, car tyres, navigation and the use of coal tar and creosote, primarily as wood protection agents in hydraulic engineering. Atmospheric deposition is the main pathway of emissions. This pathway of emission can above all be influenced through an international approach towards reducing emissions into the air.

In most states belonging to the IRBD Rhine, it is prohibited to include PAH in coal tar coatings used for ships in inland navigation. The contract on waste originating from navigation of the Central Commission for the Navigation of the Rhine (CCNR) includes regulations for PAH from bilge water and other wastes. This contract entered into force on 1 November 2009.

The sources of PAH are very varied. The objective will not be achieved, but international measures may still contribute to a considerable reduction.

Atmospheric deposition is the most important emission pathway for mercury; coal-fired power plants are an important source. Activities towards reducing mercury emissions are going on at the national, European and worldwide level. Within the implementation of the worldwide convention on mercury (Minamata Convention of 2013) work is going on aimed at describing the best available techniques and environmental practice. The target is to protect human health and the environment from mercury exposition by reducing the occurrence of Hg in the environment and, if possible, by gradually phasing out Hg. The European Union, the Netherlands, Germany, Switzerland, Luxemburg, Austria, Belgium and Italy have already signed this convention which will presumably enter into force in 2018.

Since September 2008, there is a ban on applying TBT-compounds in anti-fouling paints on all ships sailing under the flag of the EU/IMO and entering EU ports. If ocean-going vessels are considered to be the most important source of TBT-compound emissions, the values in excess stated in marine and transitional waters in the past years are easy to explain. In the meantime, the use of this (ubiquitous) substance has gradually been phased out in almost all product applications, however, due to diffuse sources, the substance is regularly being detected.

Measures concerning hexachlorobutadien and bis(2-ethylhexyl) phthalate are not further discussed here. For further information, please refer to the Part B reports.

Analysis results show that the EQN for perfluorooctanesulfonic acid (PFOS), a new “ubiquitous substance” to take into account in additional monitoring and programmes of measures as of 22 December 2018 (Directive 2013/39/EU) will presumably not be respected everywhere[78]. PFOS is a known group of PFT and is applied in different areas. In the EU, the application of PFOS has been restricted by the Directive 2006/122/EC. These restrictions do today not apply to certain applications, e.g. applications in photography, photo-lithography, paper production or galvanic processes. Furthermore, due to the Stockholm Convention, PFOS is today subject to worldwide restrictions. At EU level, as at the international level, efforts are made to replace PFOS (and PFOA) in production. However, the use of other compounds belonging to the group of fluorosurfactants and polyfluorinated surfactants is increasing.

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[78] ICPR report no. 215 (2014)

Further measures (historical burdens etc.)

Releases from water sediments may be a long-term problem. Therefore, the objective will possibly not be achieved.

Like HCB, PCB belongs to the category of pollutants negatively impacting sediment quality. No direct HCB discharges are known, but indirect pollution is due to polluted water sediments. Heavily polluted sediments must be cleaned up to the greatest possible extent (see statements in the following paragraph). As releases from water body sediments continue, the achievement of the objective does not appear to be inherent.

Human interferences with the water system (construction of dikes and impoundments) have caused a thorough change of the sediment household of the Rhine. Apart from these hydromorphological changes, considerable discharges of pollutants over recent decades have generated great amounts of polluted sediments. This still continues to negatively impact sediment quality as old, polluted sediments in the Rhine and its tributaries may be whirled up during floods or dredging. When dealing with dredged material, ecological considerations are taken into account, in Germany e.g. based on the Guideline for Handling Dredged Material in the Inland.

The ICPR has drafted an overall strategy for sediment management along the Rhine[79] aimed at sustainable sediment and dredging management: 22 of the 93 analysed sedimentation areas have been classified as areas at risk, 18 as “areas of concern”. For areas at risk remediation measures have been defined, for the “areas of concern” intensive surveillance was recommended. By the end of 2013[80], 10 of the 22 areas at risk identified in the Sediment Management Plan Rhine (2009) had been cleaned up. Rehabilitation work has been concluded at 11 of the 22 sedimentation areas located in the Netherlands. During this work, some 3.5 million m^3 of polluted sediments were deposited in different land fill deposits, the total costs entailed in the Netherlands amount to about 80 million €.

Within the Permanent Commission for the Upper Rhine, France and Germany are carrying out further investigations on the pollution of sediments of the Upper Rhine with hexachlorobenzene (HCB). As a result of these analysis, the impoundment Strasbourg can be excluded as area of risk type A. The results of investigations carried out at the weirs in Marckolsheim and Rhinau show that the HCB concentrations in sediments are distributed such that a selective removal of sediments for rehabilitation purposes does not seem to achieve the objectives. Apart from the sediments located immediately upstream of weirs (at a depth of 2 to 3 meters in Marckolsheim as well as in Rhinau) there are no areas in the centre of the openings to exclude from rehabilitation and securing measures due to economically viable reasons. During rehabilitation, heavily consolidated areas where no dredging is done for navigation purposes (upstream end of the area of investigation at Marckolsheim) are not be taken into account. No risk of pollutant discharge is to be expected from these areas.

Plant protection agents

The possibilities of reducing pollution of diffuse origin are presently being elaborated within an ICPR expert group taking plant protection agents and their input pathways into water bodies as an example. A technical report on this subject will presumably be published in 2016. Due to regularly detected increased isoproturon concentrations in the Moselle and the Rhine, the ICPR and the ICPSMS - where an expert group exists on this issue - increasingly pay attention to this substance.

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[79] ICPR report no. 175 (2009)

[80] ICPR report no. 212 (2014)

Micro-pollutants - substances relevant for drinking water

Micro-pollutants are a new challenge for water protection. In today's normal mechanical-biological wastewater treatment plants many micro-pollutants are not or only partly treated and thus discharged into the water bodies. So far, research has not gone far enough to determine, whether the effects of new substances (micro-pollutants) are hazardous to aquatic ecology.

Based on the decision of the Rhine Ministers in 2007, the ICPR has intensively worked on the assessment of the relevance of micro-pollutants for the Rhine e.g. due to pharmaceutical residues and has recommended relevant reduction strategies[81]. Evaluation reports are available for several substance groups, such as industrial chemicals[82], complexing agents[83], odoriferous substances[84], radio contrast agents[85], oestrogens[86], biocidal products and anti-corrosive agents[87] as well as medicinal products for human use[88].

In addition and based on the ICPR strategy to reduce micro-pollutants[89], the following substances mostly relevant for drinking water were analysed: acesulfam, amidotrizoe acid, AMPA, bisphenol A, carbamazepine, diclofenac, 1.4-dioxan, diglyme, DTPA, EDTA, ETBE, glyphosate, iopamidole, iopromide, 2-methoxy-2-methylpropane and tributyl-cation. Among these substances, exceeding values were registered for the radio contrast agent **iopamidole** along the Middle and the Lower Rhine and on several tributaries and for the pain reliever **diclofenac** in several tributaries to the Lower Rhine. In River Emscher, exceeding values were registered for **bisphenol A** and **glyphosate**.[90]

Different measures are implemented in order to reduce the discharge of micro-pollutants into water bodies. They e.g. include pilot projects (e.g. in the German federal states Baden-Württemberg and North Rhine-Westphalia and in the Netherlands) and competence centres (e.g. in the German federal states Baden-Württemberg, Rhineland-Palatinate and North Rhine-Westphalia) dealing with the issue of micro-pollutants.

In Switzerland, selected wastewater treatment plants will be equipped with additional treatment stages by 2040, targeted at eliminating organic trace substances in order to protect drinking water resources and the aquatic fauna and flora. Thus, in areas with particularly polluted water bodies, a broad scope of organic trace substances will be eliminated from municipal wastewater. On 21 March 2014, the parliament adopted the funding of means for the whole of Switzerland earmarked for the extension of individual wastewater treatment plants and the federal law on water protection (Gewässerschutzgesetz, GSchG, SR 814.20) of 24 January 1991 was modified accordingly[91].

The ICPR has been charged to establish a balance on the development stated by 2018 and to decide on this basis, which measures targeted at reducing micro-pollutant inputs via the decisive pathways are to be taken[92].

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[81] ICPR report no. 215 (2013)
[82] ICPR report no. 202 (2013)
[83] ICPR report no. 196 (2012)
[84] ICPR report no. 194 (2011)
[85] ICPR report no. 187 (2011)
[86] ICPR report no. 186 (2011)
[87] ICPR report no. 183 (2010)
[88] ICPR report no. 182 (2010)
[89] ICPR report no. 203 (2013)
[90] The basic assessment criteria are found in the relevant ICPR reports.
[91] 13.059 - Message concerning the modification of the water protection law “Verursachergerechte Finanzierung der Elimination von Spurenstoffen im Abwasser” of 26 June 2013.
[92] Communiqué of Rhine Ministers (2013)

Measures aimed at improving the quantitative groundwater status

In the brown-coal mining area along the German-Dutch border, percolation and compensatory measures ensure that ecosystems on both sides of the frontier depending on groundwater are not at risk.

For the two groundwater bodies in Rhineland-Palatinate which are still in a poor state, a reduction of groundwater abstraction is planned, as soon as substituting sources can be developed.

7.1.3 Harmonisation of water uses (navigation, energy production, flood protection, space-relevant uses and others) with environmental objectives

This fourth important management issue in the IRBD Rhine is more of a cross-sector approach. The functions of drinking water, water for agriculture and factories, water and transportation, inland fishery, recreation and tourism must be harmonised with ecosystem protection. That also implies the necessity of a continual exchange with water users.

The ICPR can look back upon a long tradition when cooperating with groups protecting and using the water environment. Already when implementing the Rhine Action Programme, the exchange of information with drinking water works, industry, navigation and ports was intensive. Since 1998, non-governmental organisations (NGO) have been admitted an observer status in almost all ICPR boards. Once these organisations are acknowledged as observers, they may not only participate in the plenary assemblies, but also in working and expert groups. Since 2010, four more NGOs (Arbeitsgemeinschaft Revitalisierung Alpenrhein / Bodensee, WWF Switzerland, WWF Netherlands, EurAqua Network) have joined in.

The present list of acknowledged NGOs is attached as Annex 8. Therefore, by participating in the work of the ICPR, the representatives of environment organisations, industrial federations, drinking water works and scientific associations are aware of current issues and decisions and have taken part in discussions on the different levels of work.

During the last years, more and more congresses and workshops have been staged with participants from different user groups in order to sensitize them for the achievement of environmental objectives and to search for common solutions to the problems at stake.

In particular, the following events have been staged:

ICPR Workshop: Micro-pollutants from diffuse sources, 23/24 February 2010, Bonn

ICPR workshop “Master Plan Migratory Fish Rhine”, 27/28 April 2010, Freiburg

ICPR Workshop Warning and Alarm Plan Rhine, 28/29 September 2010, Koblenz

ICPR Workshop: Effects of Climate Change on the Rhine River Basin, 30/31 January 2013, Bonn

ICPR expert meeting: Fishways in the problematic area Vogelgrün/Breisach, 23 September 2014, Colmar

ICPR Workshop “Further development of substance monitoring in the Rhine”, 5/6 March 2015, Bonn

It is important that all users and stakeholders are involved in decision-making processes on measures to be taken in order to achieve a sustainable development of the river system according to the requirements of the WFD. In all states, federal states or regions there are different bodies (e.g. representatives of local authorities, farmers, industry, consumers, NGO, power producers, chambers of commerce) which are informed at different levels of detail and are thus involved in the planning of measures.

7.2 Summary of measures according to Annex VII A, No. 7 WFD

7.2.1 Implementation of EU regulations on water protection

Attention is drawn to the information on the implementation of EU regulations on water protection in the programmes of measures of the EU member states in the international Rhine river basin district.

7.2.2 Recovery of costs for water use

The WFD regulates the principle of cost recovery in Article 9, Par. 1. Cost recovery is based on national regulations and is thus presented at the national level. At present, environmental and resource costs are only taken into account in so far as they are internalised. Member States located in the Rhine catchment have analysed their cost recovery in different ways. All analyses have in common that the costs of all steps of drinking water supply (production, preparation and distribution of drinking water) and of sewage disposal (wastewater collection, discharge and treatment) have been investigated into. Furthermore, in all states apart from the Netherlands and France, cost recovery is not being analysed separately for the sectors household, industry and agriculture, as the required data are not available.

It is underlined that due to differing methods of analysis, the resulting degrees of cost recovery are not comparable.

For the different states, the analysis shows the following.

Austria

For the National Water Management Plan 2009, cost recovery for public water supply and wastewater disposal in 2006 was calculated on the basis of the total costs and total revenue of water services largely provided by municipalities.

According to expert judgement, the contributions of industry to cost recovery for water services amounted to 20 to 25 %, that of households to 70 to 75 % and that of agriculture to 2 to 5 %. The order of magnitude of the share of contribution of each of these sectors also corresponded to the share of the sector in water services. Taking into account present results of economic analysis, these assumptions made in the National Water Management Plan 2009 still seem to apply.

The current analysis of the price for water and wastewater and of cost recovery (based on data from 2010 to 2012) takes into account all costs of ongoing operation, investment costs in the plants as well as internalised environmental and resource costs. The resulting cost recovery for water supply is 96 %, that for wastewater disposal 106 %.

Environmental and resource costs have been internalised by applying different financial instruments (charges, environmental duties, etc.) and are taken into account in the detailed financial costs.

France

Calculation of the rate of cost recovery

The French Ministry of Ecology has decided to restrict the calculation of the rates of cost recovery to a simplified analysis only taking into account financial transfers between sectors.

This simplified calculation neither takes into account environmental costs, nor the problem of infrastructural renewal of services.

The Ministry of Ecology applies the following method:

The rate of cost recovery results from the following ratio: A / (A+B+C), whereas:

A = Amount the user pays for the service (water bill or expenditures for own bills of industry not connected and of agriculture);

B = Remaining sum (aid - charges) Agences de l'Eau;

C = Amount paid by taxpayers (subventions by the Départements and regions)

Households and equivalent domestic activities

The aim of the calculation of cost recovery for households and equivalent domestic activities is to determine, whether the revenue of public drinking water supply and wastewater treatment at the same time covers current expenses and costs for renewing the infrastructure, i.e. wastewater treatment plants, drinking water treatment plants and water supply networks.

The rate of cost recovery for households and equivalent domestic activities in the Rhine catchment amounts to 101.7 % which means that costs in connection with public water supply and wastewater treatment and of collective wastewater treatment are being covered. It is recalled that this method does not take into account required recapitalisation costs. If depreciation was taken into account, the rate of cost recovery would be below 100 % (about 90 %).

Industry

The calculation of cost recovery for industry is based on operational costs and investment costs. This allows to measure the financial investment of the industry for wastewater treatment and resource protection and it may be checked, whether the polluter pays-principle is being applied.

The rate of cost recovery of industrial activities in the Rhine river basin amounts to 97.3 % and thus the costs are almost recovered.

Agriculture

During recent years, and with a view to protecting water resources, farmers, in particular livestock breeders have invested in installations contributing to a better control of farmyard runoff. Also, irrigation generates operational and investment costs for farmers, which should be determined.

When demonstrating the polluter pays-principle, these operational and investment costs must be compared to the costs for water supply and wastewater treatment.

The rate of cost recovery on agricultural activities in the Rhine river basin amounts to 71 % and thus the costs are not completely recovered.

Germany

In Germany, water services cover drinking water supply and wastewater disposal.

According to the requirements of WFD Article 9, Par. 1, the principle of cost recovery for water services including environmental and resource costs is applied based on the costs-by-cause rule. Apart from regional exceptions it may be generally admitted that, in Germany, resource costs due to water shortages hardly occur.

The instruments of sewage taxes (nationwide) and water abstraction charges (in 13 federal states) largely internalize environmental costs.

Above all, the costs-by-cause principle requires to clearly show all costs of water services and to impose them on the users.

The principle of cost recovery is ruled in the corresponding Local Tax Acts of the federal states. This means that the revenue of one accounting period - normally the calendar year - must cover the costs for the operation of water supply and wastewater disposal plants. At the same time, a general interdiction of cost overrun applies. Thus, it is not permitted to generate more revenue than what is required to cover operational costs. These principles apply, no matter whether user charges or contributions under private law are charged[93]. If, to a considerable extent, usage fees to be calculated in advance must be based on estimations of presumable costs as well as probable wastewater quantities, jurisdiction tolerates a slight cost overrun to a certain extent. The authorities in charge are obliged to compensate an over-recovery or under-recovery of costs in the following years.

The water services are under municipal surveillance or control of anti-trust abuse.

The German water management is carrying through numerous benchmarking projects which are generally commissioned by the Ministries of Economy, Interior and Environment of the federal states and partly the water boards themselves order the projects. Among the performance parameters, the cost-effectiveness of the water services water supply and/or wastewater discharge are of particular importance. Within some projects, the cost recovery is also determined based on a comparison of the costs and the returns of the different water services.

Even though the benchmarking projects are mainly initiated to strengthen the economic and technical performance of business, these projects deliver a large number of economic data and information which may also be relevant for the economic analysis and which are constantly updated within these assessments carried out 1-3 times per year.

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[93] However, private drinking water suppliers are allowed to make profits to a certain extent.

Table 14: Benchmarking projects in German federal states in the Rhine catchment

Benchmarking project	Rate of cost recovery water supply	Rate of cost recovery wastewater disposal
North Rhine-Westphalia	2007: 100.0 % 2008: 101.6 % 2009: 99.5 %	
Rhineland-Palatinate	2004: 99.6 % 2007: 99.7 %	2004: 100.0 % 2007: 101.0 %
Bavaria	2010 after network supply < 0.5 million m³ per year 102 % < 0.5 - 1.0 million m³ per year: 101 % 1.0 - 2.5 million m³ per year: 99 % > 2.5 million m³ per year: 103 %	2010: 94 %
Baden-Württemberg	2005 – 2007: 106.0 %	2006: 99.0 % 2007: 98.0 %
Lower Saxony	2010: 105.73 % (average)	
Thuringia	2013: 110.0 %	2013: 107.0 %

Luxembourg

According to Article 2, Item 42 of the Luxembourgian Water Law of 19 December 2008 *(Loi du 19 décembre 2008 relative à l'eau),* water services include all services which supply the following for households, public institutions or economic activities:

- Abstraction, impoundment, storage, treatment and distribution of surface water or groundwater;
- Plants for collecting and treating wastewater or rainwater which subsequently discharge into surface waters.

The water price and the cost recovery for services in connection with water use are governed by the Articles 12 to 17 of the Water Law of 19 December 2008. In order to achieve cost recovery, there are water charges to be paid by the users of water services, which are calculated by the municipalities and consist of charges for drinking water and for wastewater. According to Article 12 of the Water Law, the price schemes for water differentiate between three sectors: industry, households and agriculture, each of which is supposed to appropriately contribute to cost recovery.

Since 1.1.2010, the global costs for planning, constructing, operating, maintaining and servicing water supply and wastewater disposal infrastructures and their depreciation may be covered by the fees for water for human consumption *(redevance eau destinée à la consommation humaine)* and wastewater *(redevance assainissement)*. Among others, the water price results from these two fees collected by the municipalities and their agencies. Thus, in future municipalities will be able to sustainably maintain the infrastructures for drinking water and wastewater at a high quality level. Since the water price and the regulations on charges are determined individually by the municipalities, the water price may differ from one municipality to the next.

In addition, two supplementary taxes have been introduced in order to take into account environmental and resource costs, the tax on water abstraction *(taxe de prélèvement d'eau)* and the tax on wastewater *(taxe de rejet des eaux usées)*. The Luxembourgian

Water Law has fixed the tax on water abstraction at 10 Cent per m^3, while the tax on wastewater is annually determined in a Grand-Ducal regulation. In 2014, it amounted to 15 Cent per m^3. These taxes are entirely dedicated for the Water Management Fund *(fonds pour la gestion de l'eau)*, which provides public financial support to water management projects. As an example, the Water Management Fund supports initial investments in the fields of wastewater treatment, rainwater management, river maintenance, and river renaturation. The conditions of use and purpose of use for the subsidisation projects with means of the Water Management Law are regulated by the Water Law.

It is recalled that, taking into account environmental and economic effects and certain geographical conditions in the different regions of the Grand Duchy of Luxembourg, the cost recovery for the three sectors households, industry and agriculture amounting to about 85 % in 2012 was acceptable.

Belgium (Wallonia)

The cost recovery of public water supply and wastewater discharge has been looked into in Wallonia. The cost recovery for drinking water production and supply in the IRBD Rhine and in Wallonia is estimated at 85 % for the two sectors agriculture and households and at 78 % for the industry. The cost recovery for wastewater collection and treatment based on taxes and charges for actually produced pollution is as follows: Industry 28 %, households 54 %.

If calculations are based on the actually treated load of the wastewater treatment plant (which, in the Wallonian part of the IRBD Rhine only amounts to 65 % of the actual load), rates of cost recovery are considerably lower: Industry 25 % and households 30 %.

Netherlands

Almost all costs for water quality management are financed by local and regional charges of water boards and municipalities and costs for drinking water. In the Netherlands, there are five different water services:

- Production and supply of water: This concerns the production and supply of drinking water, process water (including irrigation in agriculture) and cooling water. In the Netherlands, the costs for producing and supplying drinking water are borne by the water supplier and passed on to the consumer, partly by charging fixed costs for the supply network, partly by charging a cost-covering fee per m^3 water for the production and treatment of tap water (Article 11 of the Law on Drinking Water).
- Collecting and discharging rainwater and wastewater: This concerns the sewer, including the groundwater drainage in cities. Wastewater and rainwater are collected and treated, and measures are taken to avoid or limit detrimental consequences of the groundwater level. The costs for investments, for the administration and maintenance of the sewer are borne by the municipalities. The major part of these costs is counter financed by sewerage charges (Article 228a of the local law). A number of municipalities is financing these costs with the general means of the municipality.
- Wastewater treatment: The construction, taking over, improvement, management, maintenance and operation of treatment infrastructure (transportation pumps and conducts, wastewater and sludge treatment plants) provide the treatment of wastewater and its discharge into surface waters respecting the corresponding legal requirements. The costs are covered by the wastewater treatment charge (Article 122d of the Law on Water Boards) which the water boards (waterschappen) charge for any discharges into the sewer system and treatment infrastructures as well as by the pollution fee (Article 7.2 of the Water Law) for

discharges into surface waters. The amount of the fee is determined on the basis of the number of pollution units.

- Groundwater management: The groundwater management water service concerns the quantity management of deeper aquifers, which in particular consists of the regulation and control of groundwater abstraction. The groundwater charge (Article 7.7 of the Water Law) contributes to covering the costs of the provinces. These abstractions concern voluminous abstractions by drinking water works and industry subject to license and charges, as well as smaller abstractions by households and agriculture. It does not make sense to require charges for these smaller abstractions, as the costs for meter readings would be far too high compared to the revenue. Furthermore, the share of all of these smaller abstractions is limited compared to the entire abstraction (< 10 %).
- Regional management of water body systems: This concerns the management of water body systems by water boards. An important task is to avoid flooding (flood protection in regional waters). Since the water boards at the same time manage groundwater near to the surface in rural areas by regulating the water table (water level management), this task, as well as drainage by agriculture, is part of the “management of water systems”. Water boards cover the costs with charges for the water system (Article 117 of the Law on Water Boards).

For each of these water services it has been determined, who is in charge of the supply, who uses it, which costs arise and which share of the costs is borne by the different users of the water services concerned. Thus, 96 to 104 % of costs for water services are borne by the users (see Table 15). Deviations from 100 % refer to annual variations. Considering a longer period, the cost recovery for all water services amounts to 100 %. And this is necessary, as, on the long run, all costs must be covered by the fee concerned without generating any profit.

Table 15: Cost recovery mechanism (KTW) and costs and revenue of public and own services in 2012 (in million €/year).

	Mechanism	**Costs 2012**			**Revenue 2012**			**KTW 2012**
		Public	Own service	Total	Public	Own service	Total	
Production and supply of water	Drinking water fee	1,362	425	1,787	1,362	425	1,787	100
Collecting and discharging rainwater and wastewater	Sewerage fee	1,415	0	1,415	1,352	0	1,352	96
Wastewater treatment	Wastewater treatment fee	1,284	353	1,637	1,292	353	1,645	100
Groundwater management	Groundwater fee, fee water system	18	0	18	18	0	18	100
Water system management	Water system fee	1,384	47	1,431	1,437	47	1,484	104
Sum		5,463	825	6,288	5,461	825	6,286	100

The costs do not only concern the management and maintenance costs, but equally investment costs. Also, services supplied by the consumers themselves are part of the individual water service (personal contribution).
Example: the use of cooling and process water by industry (part of the water service water production and supply). The industry takes care of this service on its own behalf and bears all costs for this water service. Therefore, per definition, the cost recovery for this personal contribution amounts to 100 %.

The mechanism of cost recovery for water services is legally consolidated. This secures that anyone using a certain water service will also bear the corresponding costs and that the different users and sectors (agriculture, households and industry) always adequately contribute to the costs of each water service.

WFD, Article 9, Par. 1 also mentions environmental and resource costs. The major part of the costs for water services relates to environment protection and may be considered as environmental costs. Since these costs are part of existing fees, these are internalised environmental costs. The costs for additional measures may be considered to be the not yet internalised share of the environmental costs. As soon as the measures are implemented, the costs arising for all those concerned are spread on the different users in the usual manner.

Thus, in the end, these environmental costs are also internalised. Under normal conditions, the water system management sees to the availability of sufficient water for the different uses, so that there is no significant lack of water in the Netherlands. Therefore, resource costs are considered to be negligible and are not further developed.

7.2.3 Water bodies for drinking water abstraction

In the states, resp. federal states/regions of the Rhine catchment area, a large share of the drinking water supplied comes from groundwater (by bank filtration, artificial groundwater recharge and direct abstraction). For the management of these water bodies, this also leads to corresponding protection requirements aimed at protecting drinking water.

The definition of water conservation areas is one particular means of protecting drinking water supplies. See Map K 9.

7.2.4 Water abstraction or impoundment

Apart from in Luxembourg, there are no water abstractions or impoundments significant for part A. Reference is made to national legislation and management reports (parts B).

7.2.5 Point sources and other activities impacting the status of waters

With respect to overall consideration of the international Rhine river basin district, attention is drawn to the four major management issues dealt with in Chapter 7.1.

7.2.6 Direct discharges into groundwater

Direct discharges into groundwater are not relevant at river basin district level (Level A). A detailed description of the effects of cases in which authorisation was given for direct discharges into groundwater is provided in the management reports (Parts B).

Artificial refilling or recharging of groundwater bodies are locally limited.

7.2.7 Priority substances

Please refer to details of Chapter 7.1.2 concerning the relevant management issues.

7.2.8 Accidental pollution

Prevention of accidents and security of industrial plants

In practice, accidents in industrial plants may result in far-reaching, transboundary effects on waters – in particular restrictions of their use as drinking water or industrial water, and may damage the aquatic ecosystem.

Therefore, “Recommendations of the International Commission for the Protection of the Rhine on the Prevention of Accidents and Security of Industrial Plants” were drafted during recent years and can be downloaded from the ICPR homepage (www.iksr.org). The national regulations of the Rhine-bordering countries correspond to these recommendations.

The analysis of accidents along the Rhine shows a distinct reduction of the number of accidents in such plants, but, at the same time, discharges from navigation have increased during 2004 to 2008 and decreased again subsequently (Figure 44).

The implementation and control of the regulations under the CDNI agreement require water pollution due to waste from inland ships to be further reduced in the contracting states Netherlands, Germany, Belgium, France, Switzerland and Luxembourg.

Warning and Alarm Plan

In 1986, the ICPR introduced a Warning and Alarm Plan to avert danger due to water pollution and to detect and prosecute the originators of pollution incidents (discharges, accidents in industry or navigation).

Seven international main warning centres collect and distribute the reports (see Figure 45). When assessing an alarm, the international main warning centres and the competent authorities have a flow time model, a set of guidance values for “alarm-relevant” concentrations and loads, lists of experts, substance data banks and further means at their disposal.

Within the Rhine WAP, the reports are passed on upstream (search reports) and downstream (information or warning) with standardised forms in three languages (German, French, Dutch). The development of reports passed on over the WAP Rhine during 1986 to 2014 is shown in Figure 44.

Currently the ICPR is changing the so far fax-based WAP Rhine to an internet-based system.

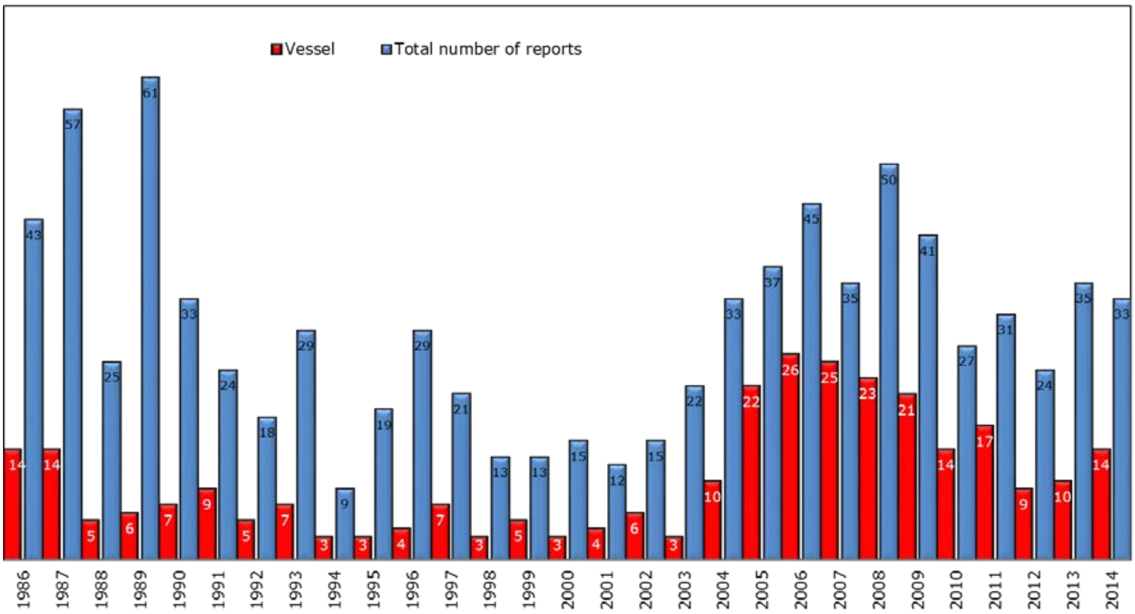

Figure 44: Development of the number of reports due to navigation between 1986 and 2014 compared to the total number of reports.

During the period between the end of the 1980s until the end of the 1990s, the number of reports decreased, between 1998 and 2003 there were between 13 and 22 reports. Since 2003, the total number of reports has again risen and reached up to 50 per year.

Since 2000, the number of navigation-related reports have distinctly increased and reached a maximum (of 26 reports) in 2006. While, until the beginning of 2000, navigation-related reports were mainly due to oil spills, since 2004, increasingly reports related to MTBE, BTX (benzene, toluene, xylene) appear, which may also be due to more sensitive analytics. Between 2005 and 2007, more than 50 % of the total number of reports concerned discharges from navigation.

The International Main Alert Centres issue warnings beyond the information reports in cases of water pollution incidents implying substances noxious to water, if the amounts or concentrations concerned may detrimentally impact the water quality of the Rhine or drinking water supply along the Rhine and/or are liable to raise great public interest. In general, during the period under review, there was one warning per year.

Some sub-basins in the Rhine river basin district (e.g. the International Commissions for the Protection of Moselle and Saar) have their own warning and alarm plans in place which are detailed in the B reports.

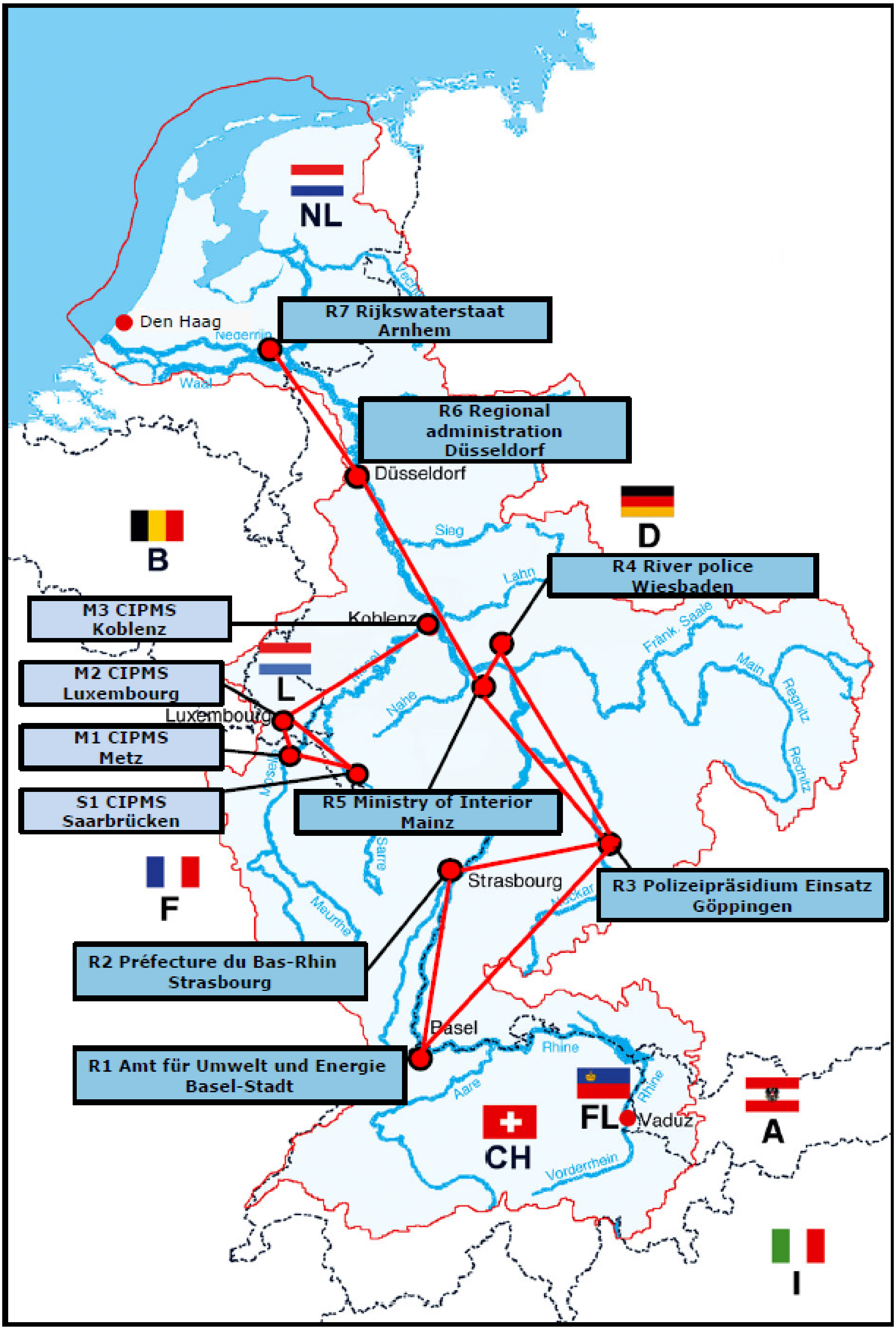

Figure 45: International Main Alert Centres - state 2014

7.2.9 Additional measures for water bodies which will presumably not achieve the objectives set out in WFD Article 4

At present, nothing can be said about additional measures according to Articles 11, Par. 5 WFD, as these will only be determined should the objectives not have been achieved after implementing the measures planned in the programmes of measures.

7.2.10 Additional measures

For additional measures concerning the main management issues, please refer to Chapter 7.1. Further details can be obtained in the management plans (B parts).

7.3 Pollution of the marine environment and connection between the WFD and the MSD

7.3.1 Pollution of the marine environment

The qualitative improvement of the marine environment, in particular of the coastal areas of the North Sea and Wadden Sea, is also achieved by inshore emission measures. Restoration and structural measures implemented in the delta and further upstream increase the self-purifying capacity of surface waters. This also results in a restoration of natural transitions (freshwater – salt water, wet – dry) and increased water detention time due to longer water retention. In the long run, this will also be beneficial for the marine environment.

With respect to the pollution by many priority and other substances, the water quality of the marine environment corresponds to the environmental quality objectives. Among the priority substances, standards for different PAH compounds, TBT (Dutch coast and Wadden Sea) and mercury (Wadden Sea) are being exceeded. These substances are classified as “ubiquitous substances”. They are persistent (long-lived) and will remain in the environment for decades in concentrations representing a significant risk, even though vast measures have been implemented, to reduce or stop emissions. Since the ban on using TBT in ship coatings entered into force in 2003, trend monitoring in suspended matter and sediments indicates considerably declining pollutant contents. In the Wadden Sea, the standard for the non-ubiquitous substance fluoranthene has equally been exceeded. This substance is above all discharged into the environment by atmospheric deposition. Along the coast of the Wadden Sea, a unique value in excess of the maximum allowable concentration of the softening agent diethylhexylphthalat (DEHP) has been registered. This is possibly no structural emission and the monitoring value might be an artefact.

Among the other pollutants, in particular silver is in excess of the maximum allowable concentration. During the next management cycle it will be analysed whether values out of limits are due to emissions or to natural causes. Furthermore, in the Wadden Sea, the maximum allowable concentrations for arsenic and benzo(a)-antracene were exceeded.

Regarding the protection of the marine environment against nitrogen, reference is made to Chapter 5.1.1, for measures to Chapter 7.1.2.

7.3.2 Connection between the WFD and the MSD

On 15 July 2008, the European Marine Strategy Framework directive (Directive 2008/56/EC) came into force. The MSD obliges the EU Member States to take required measures to achieve the good environmental status in the marine waters by 2020 and/or to maintain this status.

The MSD also includes different standards aimed at granting coordination with other European regulations. Concerning inland waters flowing into the sea it e.g. provides for cooperation with river basin commissions.

Basically, there are three issues requiring an integration of the MSD and the WFD:

1) biodiversity / diadromous fish species (migratory fish and their migration between inland waters and salt water),

2) nutrients and pollutants and

3) waste.

The relationship between both Directives is being treated in different ICPR working groups.

For the first two issues, the measures presented in this management plan based on the WFD are decisive; in this respect, please refer to Chapters 7.1.1, 7.1.2 and 7.1.3.

Free fish migration between fresh and salt water requires obstacle-free migration routes in the estuary area for the life cycle of species concerned. Therefore, in particular the planned measures to improve upstream migration into the Rhine catchment and the possibilities for downstream migration in the Netherlands are of great importance. In this connection, the measures planned in the Rhine delta at the Haringvliet locks (“De Kier”) and the fish passage at the closure embankment of Lake IJssel possibly as fish migration river presented in Chapter 7.1.1 are particularly emphasised.

According to the initial assessment following the MSD, with respect to eutrophication, the good environmental status may be achieved in the Dutch part of the North Sea in the years after 2020.[94] Since rivers play a part as input pathways, this requires that the (internationally) agreed measures within the WFD are implemented so as to achieve the targets set for nutrients. The environmental status will be carefully monitored.

Regarding the third issue, “waste”, the rivers equally play a role as discharge pathways. A difference must be made between the discharge of micro-plastics and the transport of larger pieces of trash. For micro-plastics in inland waters we only dispose of few and hardly comparable findings. There are no uniform evaluation standards or methods. Therefore, further investigations to improve knowledge are required at a national and at EU level. Presently, within the ICPR, developments in research, monitoring, pilot projects and possible approaches in the states are collected and an exchange between states is enhanced.

With respect to waste, the Netherlands have set the following targets by 2020 within the implementation of the MSD[94]:

- Reduction of the amount of visible waste along the coast
- Trend towards reduction of the waste quantities in marine organisms.

In June 2014, an OSPAR Action Plan on Marine Waste was adopted by the OSPAR Commission. A corresponding exchange of information has been started between the OSPARCOM and the ICPR and will be continued, taking into account the MSD. Presently, a questionnaire is being drafted within the OSPAR to record the state of affairs in the river basins.

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[94] Mariene strategie voor het Nederlandse deel van de Noordzee 2012-2020, deel 1, Ministerie van Infrastructuur en Milieu i.s.m. Ministerie van Economische Zaken, Den Haag, 2012

7.4 Connection between the WFD, FD and other EU directives

With respect to measures, the Flood Risk Management Directive (Directive 2007/60/EC) provides for an interlinking with the WFD. Future flood prevention measures will be decisively determined by the implementation of the Flood Risk Management Directive. Therefore, please refer to the Flood Risk Management Plan for the IRBD Rhine to be drafted in parallel by 22 December 2015.

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)" is taken into account.[95]

With respect to integrating further EU directives, the Ministers in charge of the Rhine confirmed in Basel in 2013 that, in future, activities of water and nature protection must be even more interlinked, in order to profit from mutual synergy effects. Thus, the targets for water-dependant NATURA 2000 areas must be taken into account when implementing the WFD. Creating floodplain areas serves ecological improvement and natural water retention at the same time.

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[95] Technical Report - 2014 – 078

8. Detailed list of programmes and management plans

Within the framework of the ICPR or other international co-operations, the following programmes have been drafted: Rhine 2020, Programme for Lake Constance lake trout, Habitat Connectivity. They correspond to the measures detailed in Chapter 7.1.

Further background information is available on the websites of the ICPR (http://www.iksr.org/en/index.html), the ICPSMS for the international Moselle-Saar district (http://www.iksms-cipms.org/servlet/is/391/) or of the IGKB for Lake Constance (http://www.igkb.org/start/).

Furthermore, reference is made to the websites of the states and regions/federal states (in particular to the Management Plans Part B).

Belgium: http://environnement.wallonie.be

Germany:

- **River Basin Community Rhine:** http://www.fgg-rhein.de/servlet/is/391/
- **Baden-Württemberg:** http://www4.um.baden-wuerttemberg.de/servlet/is/3577/
- **Bavaria:** http://www.lfu.bayern.de/wasser/wrrl/index.htm
- **Hesse:** http://flussgebiete.hessen.de/
- **North Rhine-Westphalia:** http://www.flussgebiete.nrw.de/index.php/Hauptseite
- **Lower Saxony:** http://www.nlwkn.niedersachsen.de/startseite/
- **Rhineland-Palatinate:** http://www.wrrl.rlp.de/servlet/is/391/
- **Saarland:** http://www.saarland.de/wrrl.htm
- **Thuringia:** http://www.thueringen.de/th8/tmuen/umwelt/wasser/euwrrl/.

France: http://www.eau-rhin-meuse.fr/sdage_2016_2021

Liechtenstein: http://www.llv.li

Luxembourg: http://www.eau.public.lu/

Netherlands: http://www.helpdeskwater.nl/onderwerpen/wetgeving-beleid/kaderrichtlijn-water/2016-2021/

Austria: http://wisa.bmlfuw.gv.at/; http://www.vorarlberg.at/

Switzerland: http://www.bafu.admin.ch/wasser/index.html?lang=de

9. Information of the public and public consultations as well as their results

Article 14 WFD requires that all Member States inform and consult the public - that is all citizens in the Rhine catchment - and actively get interested parties involved. The Directive provides for the following three consultation phases concerning the most important steps of implementation:

- Consultation concerning schedule and work programme;
- Consultation concerning the most important water management issues;
- Consultation concerning the Management Plan.

Consultations have been or are being organised by the member states resp. federal states/regions in the IRBD Rhine. For details please refer to the Part B reports.

In the IRBD Rhine, the public is informed at the national as well as at the international level. Extensive information on the river basin district Rhine and the WFD is available to the public on the ICPR internet pages (http://www.iksr.org/en/index.html). Moreover, all reports, in particular those issued at the international level, and publications ("Rhine unlimited" brochure) are available as downloads. 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 ICPR has actively involved its acknowledged observers in the work on this second Management Plan. After its publication on the website http://www.iksr.org/en/index.html on 22 December 2014, the draft of the second Management Plan for the IRBD Rhine was open for comments until 22 June 2015. All in all, the secretariat of the ICPR received ten statements. The list of acknowledged observers in the ICPR (state 2015) is found in Annex 8.

The states resp. federal states/regions co-operating in the ICPR/Coordination Committee Rhine have addressed a coordinated document to the non-governmental organisations concerning the aspects concerned by these statements, which has also been published on the ICPR website (http://www.iksr.org/en/index.html).

The states, resp. federal states/regions have chosen different approaches corresponding to specific circumstances to further active participation at a national level, in particular that of the organised public (associations in agriculture, environmental protection, of hydropower production, etc.) within the implementation of the WFD. In several cases, temporary or permanent discussion groups to assist the implementation process were established at national or regional level at an early stage. For details please refer to the Management Plans (parts B) and the information on national consultations for which links are found under http://www.iksr.org/en/index.html.

10. List of competent authorities according to Annex I WFD

The list of competent authorities is found in Annex 9.

11. Contact addresses and procedures for obtaining background documents

We refer to the list of competent authorities in Annex 9. Furthermore, reference is made to the ICPR website (http://www.iksr.org/en/index.html) and to the detailed information – including the procedure of how to procure background documents – on Part B level and relevant national websites.

Results and outlook

The European Water Framework Directive (Directive 2000/60/EC, WFD) has set new standards in water policy for EU Member States. In general, the objective of the WFD is to achieve the good status of all surface waters and of groundwater by 2015. The international river basin commissions, such as the International Commission for the Protection of the Rhine serve as international coordination platforms in order to jointly achieve this objective.

Since the ICPR does not cover the entire river basin district, the Coordination Committee was founded in 2001, which also integrates Liechtenstein, Austria and the Belgian region Wallonia into the coordinated implementation of the WFD. Switzerland is not bound by the WFD but does support the EU Member States in their coordination and harmonisation work within the framework of conventions under international law and national Swiss law. Today, the ICPR and the Coordination Committee work in a joint working structure.

The Management Plan 2015 for the International River Basin District (IRBD) Rhine (part A with sub-basins > 2,500 km²) describes the monitoring results of the Measurement Programmes Chemistry and Biology for the Rhine, the objectives to achieve and the programmes of measure. It serves as an information tool for the public and the European Commission and documents the international coordination and cooperation of the states in the river basin district.

Since the WFD entered into force, important progress has been made by 2015 in the IRDB Rhine with respect to the **four main management issues**:

(1) Due to programmes of measure, since 2000, upstream **river continuity for fish** has been restored at almost 500 transverse obstacles, and, in many places, even downstream river continuity has been improved. This was achieved by constructing or optimising upstream and downstream fish passages, enabling long-distance migratory fish to reach their spawning waters, while medium distance migratory fish have been able to change habitat. The partial opening of the Haringvliet locks in order to improve fish migration in the estuary of the Rhine and Maas river systems will be effective as of 2018. The new fish passage at Strasbourg will be taken into operation by the end of 2015, that at Gerstheim in 2017. Important initiatives were taken with respect to the further restoration of the river continuity of the Upper Rhine. The 15th conference of Rhine Ministers in 2013 had confirmed that in order to achieve the objectives of the Programme Rhine 2020 and of the Master Plan Migratory Fish Rhine, an efficient system of fish passages was to be planned and implemented at the impoundments Rhinau, Marckolsheim and Vogelgrün on the Upper Rhine, so that fish may reach the old bed of the Rhine and Basel by 2020. The ICPR is supporting and counselling the builder examining and further developing first approaches to solutions for restoring the ecological continuity.

Due to the remaining obstacles to fish migration, presently less than 25 % of existing spawning and juvenile habitats in programme waters can be reached by the indicator Rhine salmon and other migratory fish.

Furthermore, the states in the Rhine catchment have decided to increasingly focus on **downstream fish migration**. In this connection, new, innovative downstream migration techniques are to be encouraged, in order to reduce the loss of salmon and eel due to turbines.

In order to **increase habitat diversity**, along more than 100 km of Rhine river banks, structures have been removed between 2000 and 2012, along the Middle Rhine, the Lower Rhine and the Delta Rhine parallel structures or filled up groynes as shallow replacement habitats rich in structure and protected from the lapping of waves have been created. During the same period, along the entire Rhine, 80 old arms and lateral water bodies have been reconnected with the dynamics of the river. These measures improve lateral continuity and enable the recolonisation of habitats, they enhance the spreading and exchange of the aquatic fauna and flora and increase biodiversity. Furthermore, within the implementation of the Action Plan on Floods during 2000-2012, and due to the relocation of dikes and ecological flooding of flood retention areas, more than 120 km² of alluvial areas have been reactivated along the Rhine which show the above mentioned positive ecological effects.

In parallel, since 2000, similar ecological enhancement measures aimed at increasing habitat diversity and biodiversity have been implemented along many Rhine tributaries and smaller water bodies in the Rhine catchment not expressly mentioned here, but in the B-reports.

Based on the data of biological monitoring programmes 2011 / 2012, the surface water bodies in the IRBD Rhine (catchment > 2,500 km²) have been evaluated as follows: 3 % have achieved the good ecological status / the good ecological potential; half of them were evaluated as moderate, the rest of them as poorer. In the main stream of the Rhine, 63 % of the water bodies were classified as moderate, 37 % as poor.

This present evaluation of the Rhine ecosystem only reflects the present status of the system. However, the long term trends of the last 20 years still indicate distinct, sustainable ecological improvements. The future implementation of the ecological measures described will contribute to continue this trend.

In 2021, presumably 14 % of the surface water bodies will achieve the objectives set for the ecological status/potential. For 80 %, the achievement of objectives is unlikely.

The biocoenosis of the Rhine and of many tributaries continues to change distinctly, which is, among others, due to different alien species changing the dominant species proportions. These changes leave their marks in the present status classification and make it more difficult to estimate the achievement of objectives. The effects of the programmes of measure since 2009 on the biocoenosis cannot always be clearly distinguished from natural biological interactions. Due to the One-out-all-out principle, improvements stated with respect to individual biological quality elements are not seen in the overall classification, if other elements achieve a poorer classification.

(2) The **15 - 20 % reduction of the nitrogen load** discharged from the Rhine catchment into the North Sea and the Wadden Sea which had been agreed upon until 2015 was **just achieved**. The calculated nitrogen emissions have dropped by about 15 % since 2000. In per cent, the pollution due to diffuse substance inputs increase as a result of the distinct drop in point source inputs of industrial and municipal origin. Measures aimed at the further reduction of the nutrients nitrogen and phosphorus, which are largely based on changes in agricultural land use, can only be achieved in cooperation with agriculture. The current implementation of the Nitrates Directive (91/676/EEC), of the Directive on achieving a sustainable use of pesticides (2009/128/EC) and of national regulations and recommendations on the appropriate use of plant protection agents must be continued unabated.

In almost all water bodies, the ubiquitous substances mercury and the PAH compounds exceed the EQS. Generally speaking, and because of their persistence and widespread occurrence, there are few measures apt for reducing the pollution with these substances on the short or medium term. At many monitoring stations, fluoranthene, a PAH compound not classified as ubiquitous, is also in excess of the

EQS so that this substance is the reason for the classification as “failing to achieve good”.

Furthermore, sediments are polluted by PCB and HCB, and, in 2009, a Sediment Management Plan was adopted which is presently being implemented. In most of the 22 areas at risk designated by the Sediment Management Plan there are high PCB concentrations. Thirteen areas at risk are located in the Netherlands and are all polluted by high PCB contents. In the meantime, 10 sites have been cleaned up. The vastest cleaning up concerned the Ketelmeer-West. Numerous investigations during the last years suggest that, for many years, the HCB pollution has spread from the original discharge location near Rheinfelden (former production of PCP and chlorosilane) and across the chain of barrages in the Upper Rhine. Results of analysis and corresponding recommendations for action are available.

(3) The **pollution of industrial and municipal point sources** has been further **reduced**. Inputs of priority substances and of substances relevant for the Rhine from wastewater treatment plants and the industry have been distinctly reduced - apart from nickel inputs - and the point source nitrogen and phosphorus discharges from industry have dropped by more than half, those of municipal wastewater treatment plants by about one third. Since the beginning of the seventies, industry has intensively strived for and implemented measures to avoid and reduce substance inputs. Today, a priority of most works is to avoid wastewater production. In plants, where this is not entirely possible, purification technologies are used often implying several wastewater focussed treatment stages.

(4) The fourth important management issue is cross-sectoral. That means that different **functions of use** such as drinking water, water for agriculture and factories, water and navigation, inland fishery, recreation and tourism must be **harmonised with ecosystem protection**. That also implies the necessity of continual exchange with water users, e.g. by NGO participation in ICPR work and the involvement of all users in different workshops.

When treating the four major management issues, **effects of climate change** and changes in the discharge regime of the Rhine, among others **more frequent flood events and longer lasting phases of low water** must in future increasingly be taken into account. In the framework of the ICPR, the relevant basis has been established within different studies of scenarios for **water management and water temperature**. The ICPR Strategy for Adapting to Climate Change looks into this in detail. In the years to come, different ICPR bodies will deal with possible strategies to adapt to climate change in depth. On the positive side it may already now be stated that the shutting down of some nuclear power plants in the Rhine catchment between Karlsruhe and Mainz (Philippsburg Block I, Biblis, Neckarwestheim Block I) since 2011 has verifiably led to less stress on Rhine temperatures along the northern Upper Rhine at Mainz. Further power plants will be shut down in the years to come.

Micro-pollutants (e.g. medicinal products, odoriferous substances, insecticides, hormones) figure among the challenges for the future. In existing wastewater treatment plants working according to the current state of the art, these substances are not or only partly removed from the wastewater. An assessment of the effects on the environment is partly possible for individual substances but not yet possible for the sum of individual substances. Certain micro-pollutants may detrimentally affect the Rhine ecosystem or drinking water production and drinking water quality.

Within a dedicated strategy, the ICPR has considered the relevant groups of substances and their input pathways. The potentially most efficient measures aimed at avoiding and reducing these inputs from municipal and industrial wastewaters have been drawn up. The states in the Rhine catchment will continue working on this issue. Currently, a strategy aimed at limiting substance emissions from diffuse sources is drafted, using plant protection agents as an example.

ANNEXES

Annex 1: Ecological assessment of the monitoring stations incorporated in the surveillance monitoring programme according to WFD

State: December 2015	very good	1	*Ec. potential*	**General physical-chemical parameters**	
* Category: For the High Rhine 2, in 2009, the category "heavily modified" applied	good	2	2	All environmental quality standards respected	🟩
** Phytoplancton, macrophytes / phytobenthos: In Germany, the ecological status and not the ecological potential is determined even in heavily modified water bodies. In DE-BW the results for macrophytes / phytobenthos refer to the entire biological element. In France, no macrophytes were classified, for the phytobenthos the potential was determined.	moderate	3	3	one or more environmental quality standards not respected	🟨
*** Macrozoobenthos and fish: In FR, hydromorphology was not taken into account and there is no procedure available to classify the potential. So far, the ecological potential has not been determined for the fish fauna in the tributaries to the Lower Rhine in DE-NW. The deviation from the One-out-all-out-principle for the water bodies of the Upper Rhine 7 and for the Middle Rhine has been coordinated between DE-RP and DE-HE (for fish, the results obtained in DE-RP are more representative).	Poor	4	4	Assessment of quality element not required	**./.**
**** Hydromorphology: For France "severe" applies = "considerable reversible hydromorphological pressure". Due to the different classification, no harmonisation was done between F and DE-BW.	bad	5	5	No inventory or assessment of the element / data insufficient	▒
***** Total classification If the 4 biological elements were all classified as "good" and one of the supporting parameters was "not good", the total ecological classification is "moderate" (= 3 = yellow). In the Netherlands, the 5 scale classification is also applied for physical-chemical parameters. In France, a severe hydromorphological impairment combined with a good ecological classification results in a poor ecological potential; with a moderate ecological classification the potential will be b ad.				Differing classifications (It has not been possible to achieve an agreement for this biological quality element.)	🟪

Water body	**River km**	**ICPR survy monitoring - monitoring station in the water body**	**State / federal state**	**Category***	**Phytoplankton****	**Makrophytes/ Phytobenthos ****	**Makrozoobenthos*****	**Fish fauna *****	Specific pollutants (see Annex 2)	General physical-chemical parameters	Hydromorphology ****	**Total classification 2009 *******	**Total classification 2015 *******
ALPINE RHINE Reichenau - Lake Constance													
Alpine Rhine		Fussach	AT/ Vorarlberg/CH (SG)	heavily modified	./.	2	2	5	good	good	not good	3	**3**
LAKE CONSTANCE													
BOD-OS Lake Constance - Upper Lake	No kilometre marking	Fischbach-Uttwil	DE-BW	natural	2	2	./.	2		good		2	**2**
BOD-USZ Lake Constance - Lower Lake		Zellersee	CH / St. Gallen	natural	2	2	./.			good		2	**2**
HIGH RHINE Lake Constance - Basel	**24-170**												
High Rhine 1 Eschenzer Horn until upstream River Aare	24-45	Öhningen	CH / DE-BW	natural	1	2	2	3	good	good	not good	2	**3**
High Rhine 2 downstream river Aare until R. Wiese inclusive	45-170		CH / DE-BW	natural	1	2	3	▒	good	not good	not good		**3**
UPPER RHINE Basel - Bingen	**170-529**												
Upper Rhine 1 - OR 1 - Rhine 1 - Old Rhine, Basel to Breisach	170-225	Weil am Rhein	DE-BW	heavily modified	1	3	3	3	good	not good	not good	3	**3**
			FR	heavily modified	./.	2	▒	2	good	good	severe	3	**3**
		Coordination result		heavily modified	1	2	3	🟪	good	good			**3**
Upper Rhine 2 - OR 2 - Rhine 2 - Loop of the Rhine, Breisach to Strasbourg	225-292	Upstream Rhinau	DE-BW	heavily modified	1	3	4	4	▒	▒	not good		**4**
			FR	heavily modified	./.	2	4	2	good	good	severe	3	**3**
		Coordination result		heavily modified	1	2	4	🟪	good	good			**4**
Upper Rhine 3 - OR 3 - Rhine 3 - impounded section of the Rhine, Strasbourg to Iffezheim	292-352	Upstream Gambsheim	DE-BW	heavily modified	1	3	3	3	▒	▒	not good		**3**
			FR	heavily modified	./.	2	5	2	good	good	severe	4	**3**
		Coordination result		heavily modified	1	2	3	🟪	good	good			**3**
Upper Rhine 4 - OR 4 - Rhine 4 - Iffezheim impoundment to upstream mouth R. Lauter	352-428	Karlsruhe	DE-BW	heavily modified	1	3	3	3	good	good	not good	4	**3**
		Upstream Lauterbourg/Karlsruhe	FR	heavily modified	./.	3	4	2	good	good	severe	4	**3**
		Coordination result		heavily modified	1	3	3	🟪	good	good			**3**
Upper Rhine 5 - OR 5 - Lauter to mouth R. Neckar	352-428		DE-BW	heavily modified	1	3	4	3	good	good	not good		**4**
			DE-RP	heavily modified		3	4	3	good	Not classified (result BW)	not good	3	**4**
Upper Rhine 6 - OR 6 - Neckar to mouth R. Main	428 - 497		DE-BW	heavily modified	2	3	3	3	▒	▒	not good		**3**
			DE-HE	heavily modified		3	3	3			not good		
		Worms	DE-RP	heavily modified	2	3	3	3	good	good	not good	4	
Upper Rhine 7 - OR 7 - Main to mouth R. Nahe	497 - 529	Mainz/Wiesbaden	DE-HE	heavily modified		3	2	4			not good		**3**
			DE-RP	heavily modified	2	3	2	3	good	good	not good	4	
MIDDLE RHINE Bingen - Bonn	**529-639**												
Middle Rhine (MR)	529-639		DE-HE	heavily modified		3	2	3			not good		**3**
		Koblenz	DE-RP	heavily modified	2	3	2	3	good	not good	not good	4	
LOWER RHINE Bonn - Kleve-Bimmen / Lobith	**639-865.5**												
Lower Rhine 1 NR 1 - Bad Honnef to Leverkusen	639-701	Cologne-Godorf	DE-NW	heavily modified	2	3	3	3	good	not good	not good	4	**3**
Lower Rhine 2 NR 2 - Leverkusen to Duisburg	701-764	Düsseldorf harbour	DE-NW	heavily modified	2	4	4	3	good	not good	not good	4	**4**
Lower Rhine 3 NR 3 - Duisburg to Wesel	764-811	Duisburg-Walsum / Orsoy	DE-NW	heavily modified	3	3	4	4	good	not good	not good	5	**4**
Lower Rhine 4 NR 4 - Wesel to Kleve	811-865	Niedermoermter / Rees	DE-NW	heavily modified	3	3	4	4	good	not good	not good	5	**4**

Annex 1: Ecological assessment of the monitoring stations incorporated in the surveillance monitoring programme according to WFD

Water body	**River km**	**ICPR survy monitoring - monitoring station in the water body**	**State / federal state**	**Category***	**Phytoplankton****	**Makrophytes/ Phytobenthos ****	**Makrozoobenthos*****	**Fish fauna *****	Specific pollutants (see Annex 2)	General physical-chemical parameters	Hydromorphology ****	**Total classification 2009 *******	**Total classification 2015 *******
DELTA RHINE Lobith - Hoek van Holland	**865.5-1032.**												
Boven Rijn, Waal	880-930	Lobith	NL	heavily modified		2	4	4	not good	2	not good	4	**4**
Nieuwe Waterweg, Hartel-, Caland-, Beerkanaal	998-1013	Maassluis	NL	artificial	2	2	2	3	not good	3	not good	3	**3**
Lake IJssel	n.a.	Vrouwezand	NL	heavily modified	3	2	2	3	not good	5	not good	3	**3**
Wadden Sea	n.a.	Dantziggat, Doove Balg west	NL	natural	2	4	3		not good	3	not good	4	**4**
Dutch coast (coastal waters)	n.a.	Noordwijk 2	NL	natural	2		3		not good	4	not good	3	**3**
Wadden coast (coastal waters)	n.a.	Boomkensdiep	NL	natural	3		2		not good	3	not good	3	**3**
RHINE-TRIBUTARIES													
Neckar		Neckar near Deizisau	DE-BW	heavily modified	3	3	3	4	good	not good	not good	3	**4**
Neckar		Neckar near Kochendorf	DE-BW	heavily modified	3	3	4	3	good	not good	not good	5	**4**
Neckar		Neckar near Mannheim	DE-BW	natural	3	3	4		good	not good	not good	4	**4**
Weschnitz		Weschnitz near Biblis-Wattenheim	DE-HE	natural	./.	3	4	3	good	not good	not good	4	**4**
Main river basin district													
Regnitz from the confluence of Rednitz and Pegnitz until the confluence with the Main-Danube-Canal (2 F044)	n.a.	Regnitz near Hausen	DE-BAV	natural	2	3	4	3	good	not good	not good	4	**4**
Main from the confluence with the Main Canal until the confluence of the Fränkische Saale (2 F119)	211 - 299.7	Main near Erlabrunn	DE-BAV	heavily modified	2	3	3	3	good	not good	not good	3	**3**
Main from Banz monastry to the confluence with the Regnitz (2 F099)	384.5 - 422.4	Main near Hallstadt	DE-BAV	natural	2	2	3	4	good	not good	not good	3	**4**
Main from the Wallstadt impoundment until the border HE/BY near Kahl (2 F146)	101.4 - 66.6	Main near Kahl	DE-BAV	heavily modified	2	3	4	3	good	not good	not good	3	**4**
Schwarzbach/Main		Schwarzbach near Trebur-Astheim	DE-HE	natural	./.	4	4	5	not good	not good	not good	4	**5**
Nidda		Nidda near Frankfurt - Nied	DE-HE	heavily modified	./.	3	3	4	not good	not good	not good	5	**4**
Kinzig		Kinzig near Hanau	DE-HE	natural	./.	4	4	4	good	not good	not good	5	**4**
Main		Main near Bischoffsheim	DE-HE	heavily modified	3	4	3	4	good	not good	not good	4	**4**
Lower Nahe		Nahe near Dietersheim	DE-RP	natural	2	3	2	2	good	not good	good	3	**3**
Lahn		Lahn near Limburg-Staffel	DE-HE	heavily modified	2	4	5	2	good	not good	not good	5	**5**
Lahn		Lahn near Solms-Oberbiel	DE-HE	heavily modified	2	4	3	3	good	not good	not good	5	**4**
Lower Lahn		Lahn near Lahnstein	DE-RP	heavily modified	3	3	4	3	not good (Zn)	not good	not good	5	**4**
Moselle-Saar area:													
Blies		Blies near Reinheim	DE-SL	natural	./.	3	3	2	not good			4	**3**
Nied		Nied near Niedaltdorf	DE-SL	natural	2	3	3	2	not good			2	**3**
Saar, Saarland - frontier FR until bortder DE-RP	25.9 - 102.8	Saar near Güdingen	DE-SL	heavily modified	./.	3	3	2	not good			**4**	**4**
		Sarre near Fremersdorf	DE-SL	heavily modified	./.		4	2	not good			**4**	**4**
Saar (DE-RP)	0 - 25.9	Saar near Serrig (no surveillance monitoring station)	DE-RP	heavily modified	3	4	4	3	good	not good	not good	5	**4**
Saar - Wiltinger Bogen (DE-RP)	4.75 - 7.81	Sarre near Kanzem	DE-RP	natural	2	3	4	3	good	not good	good	5	**4**
Alzette		Alzette near Ettelbruck	LU	natural	./.	4	2	4	not good	not good	./.	4	**4**
Wiltz		Wiltz near Kautenbach	LU	natural	./.	3	1	2	good	not good	./.	3	**3**
Sauer		Sauer, outlet at Wasserbillig	LU and DE-RP	natural	2	2	2	3	good	not good	good	3	**3**
Upper Moselle	206 - 242	Moselle near Palzem	LU and DE-RP	heavily modified	2	4	4	3	Not good (Cu, PCB)	not good	not good	5	**4**
Lower Moselle	0 - 206	Moselle near Fankel	DE-RP	heavily modified	2	4	4	3	good	not good	not good	5	**4**
		Moselle near Koblenz	DE-RP	heavily modified	2	4	4	4	good	not good	not good	5	**4**
Lower Rhine Tributaries													
Sieg		Sieg near Menden (St. Augustin)	DE-NW	natural	./.	3	2	3	not good	not good	not good	4	**3**
Ruhr		Ruhr near Fröndenberg	DE-NW	heavily modified	./.	3	1	4	not good	good	not good	5	**4**
Ruhr		Ruhr-outlet (Duisburg Ruhrort)	DE-NW	heavily modified	./.	3	5	5	not good	good	not good	5	**5**
Lippe		Lippe near Lippborg	DE-NW	natural	./.	3	3	3	not good	not good	not good	4	**3**
Lippe		Lippe near Wesel	DE-NW	natural	./.	4	4	3	not good	not good	not good	5	**4**
Delta Rhine Tributaries													
Vechte, upper reaches		Vechte near Laar	DE-NI	heavily modified		3	3	3	good		not good	4	**3**
Vechte delta Groot Salland	n.a.	Vechterweerd	NL	heavily modified		2	3	4	good	3	not good	3	**4**

Annex 2: Results of the evaluation at monitoring stations of the programme for surveillance monitoring of physico-chemical parameters and substances relevant for the Rhine according to WFD

Physico-chemical parameters, (river-specific) substances relevant for the Rhine and substances of the List of Rhine substances

🟨 **In excess of EQS/guidance value**
🟩 **Lower than EQS/guidance value**
X **no decision possible because of too high limit of determination**
\- **no measurements available**
* **Coastal waters outside the 1-mile zone: No classification required**
Numb **No EQS determined as yet**

☐ **Monitoring stations and inland surface waters**
▨ **Monitoring stations at "other surface waters"**

State: December 2015

				River	Ach near Brege	Rhine														Neckar			Weschnitz	Schwarzbach	Main				Regnitz	Kinzig	Nidda	Nahe	Lahn			Moselle			Saar			Blies	Nied	Alzette	Wiltz	Sauer	Sieg	Wupper	Erft	Ruhr	Emscher	Lippe	Vecht	Lake IJssel	Wadden Sea		Dutch coast		Wadden Sea	
				Monitoring station no.	61	60	5	1	2	7	11	12	13	32	34	35	41	43	42	8	9	10	31	28	54	24	23	25	55	26	27	19	29	30	20	15	17	18	21	22	14	52	53	56	57	16	36	37	40	38	33	39	51	44	45	46	47	48	49	50
				Name of the monitoring station	Fussach	Fussach/Alpine Rhine	Öhningen	Rekingen	Weil am Rhein	Karlsruhe/Lauterbourg	Worms	Mainz	Koblenz	Bad Honnef	Düsseldorf-Flehe	Bimmen	Lobith	Kampen	Maassluis	Deizisau	Kochendorf	Mannheim	Biblis-Wattenheim	Trebur-Astheim	Hallstadt	Erlabrunn	Kahl a. Main	Bischofsheim	Hausen	Hanau	Nied	Dietersheim	Solms-Oberbiel	Limburg	Lahnstein	Palzem	Fankel	Koblenz	Saarbrücken	Fremersdorf	Kanzem	Reinheim	Niedaltdorf	Ettelbrück	Kautenbach	Wasserbillig	Menden	Opladen	Eppinghoven	Mülheim	Mouth R. Emscher	Wesel	Vecht stuw Vechterwe	Vrouwezand	Doove Balg West	Dantziggat	Noordwijk 2	Noordwijk 10	Boomkensdiep	Terschelling 10 *
Substance	**CAS No.**	**Value (WFD-Codelist)**	**Unit**	**Status WFD resp. list of Rhine substances (rhr)**
Physico-chemical parameters (supporting the assessment of the ecological state/potential)
according to WFD, Annex V
Dissolved oxygen	n.a.	321	mg/l	Annex V	🟩	🟩	🟩		🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟨	🟨	🟨	🟩	🟨	🟩	🟩	🟩	🟨	🟩	🟨	🟩	🟩	🟩	🟩	🟩	🟨	🟩	🟨	🟩	🟩	🟨	🟩	🟩	🟩	🟩	🟩	🟩	🟨	🟩	🟩	🟨	🟩	🟩	🟩	🟩	🟩	🟩		🟩	
Water temperature	n.a.	226	°C	Annex V	🟩	🟩	🟨		🟨	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟨	🟩	🟨	🟨	🟨	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟨	🟨	🟩	🟩	🟩		🟩	🟩	🟩	🟩		🟩	
pH	n.a.	322		Annex V	🟩	🟩	🟩		🟩	🟩	🟩	🟩	🟩	🟨	🟨	🟩	🟩	🟩		🟩	🟩	🟩	🟨	🟨	🟩	🟩	🟨	🟨	🟩	🟩	🟨	🟩	🟨	🟨	🟨	🟨	🟨	🟨	🟩	🟩	🟨	🟩	🟩	🟩	🟩	🟨	🟨	🟩	🟩	🟩	🟩	🟨		🟨						
Conductivity	n.a.	330	µS/cm	Annex V	322	300			346	364		402	416	605	598	719				746	794	777	65	903	510	654	647	654	566	467	787	432	408	43	386	1.483	904	903	596	670	588	468	1184			406	296	433	853	540	4.749	1.794								
Cl⁻	n.a.	97	mg/l	Annex V	🟩	🟩	🟩		🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩		🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟨	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟨	🟨		🟩						
Total nitrogen	n.a.	2	mg/l	Annex V	-	-	0,7		1,4	1,8	1,9	2,0	2,3	2,7	2,8	2,8	🟩	🟩	🟨	4,6	5,0	4,7	4,46	4,19	4	4,5	4,3	4,53	-	2,83	3,66	3,9	3,46	3,26	3,3	2,8	3,8	3,8	3,16	3,57	3,6	3,52	4,85			5,9	3,09	4,083	2,33	3,158	5,38	5,171	🟨	🟨	🟨	🟩	🟨		🟩	
Nitrate nitrogen	n.a.	228	mg/l	Annex V	🟩	🟩	🟩		🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩				🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟨	🟩	🟩	🟩	🟩	🟩	🟩	🟩								
Orthophosphate phosphorus	n.a.	227	mg/l	Annex V	🟩	🟩	🟩		🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩				🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟩	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	-	🟩	-	🟩	🟨	🟨								
Total phosphorus	n.a.	3	mg/l	Annex V	0,05	0,11	🟩		🟩	🟩	🟩	🟩	🟨	🟨	🟩	🟨	🟩	🟩		🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟩	🟩	🟨	🟩	🟨	🟨	🟨	🟩						
One or more national classification criteria out of limit							🟨		🟨				🟨	🟨	🟨	🟨			🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨		🟨	🟨	🟨	🟨	🟨		🟨			
Below all national classification criteria					🟩	🟩				🟩	🟩	🟩					🟩	🟩																																🟩						🟩			🟩	
Rhine-relevant (river specific) substances (basis list of Rhine substances 2011 and 2014)
Inorganic substances
NH₄-N	14798-03-9	4	mg/l	2011	🟩	🟩	🟩		🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	-	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟨	🟩	🟩	🟩	🟩	🟩	🟩	🟨	🟩	🟨	🟩	-	-	-		-	
Heavy metals and metalloids (solute)
As sol.	7440-38-2	5	µg/l	2011 2014	🟩	🟩	-		-	-	-	1,0	0,8				🟩	🟩	🟩	-	-	-	0,94	< 0.5	0,77	1,33	1,13	0,65	1,67	1,2	< 0.5	1,0	< 0.5	< 0.5	0,8	3,2	1,7	1,2	1,3	1,4	1,5	< 1	1,8	🟩	🟩	🟩							🟩	🟩	🟩	🟨	🟩		🟩	
Cr sol.	7440-47-3	6	µg/l	2011 2014	🟩	🟩	0,18		0,2	0,2	-	< 0.5	0,7				🟩	🟩	🟩	0,38	0,45	0,36	< 1.5	< 1.5	< 1	< 1	< 1	< 1.5	< 1	< 1.5	< 1.5	< 0.5	< 1.5	< 1.5	< 0.5	0,7	< 0.5	0,5	1,4	1,5	< 0.5	1,2	2	🟩	🟩	🟩							🟩	🟩	🟩	🟩	🟩		🟨	
Cu sol.	7440-50-8	7	µg/l	2011 2014	🟩	🟩	0,7		0,9	1,2	-	1,6	1,5				🟨	🟩	🟨	1,8	2,7	2,3	2,5	4,9	2,2	2,8	2,3	4,2	2,9	4,4	3,4	1,8	3,6	2,3	2,7	5,0	3,2	3,1	1,8	2,4	2,4	1,6	2,3	🟩	🟩	🟩							🟩	🟩	🟨	🟩	🟨		🟩	
Zn sol.	7440-66-6	8	µg/l	2011 2014	🟩	🟩	1,03		0,6	1,1	-	< 5	3,8				🟩	🟩	🟨	3,41	4,63	4,34	-	-	6,7	< 10	< 10	-	7	-	-	< 5	-	-	68,3	7,7	25,0	7,7	< 10	< 10	6,8	< 10	< 10	🟩	🟩	🟩							🟩	🟩	🟩	🟩	🟩		🟩	
Non-volatile hydrocarbons
4-chloroaniline	106-47-8	4	µg/l	2011	-	-	-		🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	-	-	-	-	-	-	-	-	🟩	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.04	<0.04	-	🟩	🟩	🟩	🟩	-	🟩	🟩	🟩	-	-	-		-	
Pesticides
Bentazone	25057-89-0	9	µg/l	2011	-	-	🟩		🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	-	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	-	-	🟩	-	-	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩		🟩	
Chlorotolurone	15545-48-9	10	µg/l	2011 2014	-	-	🟩		🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	-	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	-	-	🟩	-	-	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩		🟩	
Dichlorprop (2,4 DP)	120-36-5	11	µg/l	2011	-	-	🟩		🟩	🟩	-	🟩	🟩	🟩	🟩	🟩	-	-	-	🟩	🟩	🟩	🟩	🟩	-	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	-	-	🟩	-	-	-	-	🟩	🟩	🟩	🟩	🟩	🟩	🟩		-	-	-	-		-	
Dichlorvos	62-73-7	12	µg/l	2011	-	-	🟩		-	🟩	-	X	X	🟩	🟩	🟩	X	X	X	🟩	🟩	🟩	X	X	-	-	-	X	-	X	X							-	-	-	X	-	-	🟩	🟩	X	🟩	🟩	🟨	🟩	🟩	🟩		X	X	X	X		X	
Dimethoate	60-51-5	13	µg/l	2011	-	-	🟩		🟩	🟩	-	🟩	-	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟨	-	-	🟩	🟩	-	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	-	-	-	🟩	-	-	-	-	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩		🟩	
MCPA	94-74-6	15	µg/l	2011	-	-	🟩		🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	-	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	-	-	🟩	-	-	-	-	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩		🟩	
Mecoprop	93-65-2	14	µg/l	2011	-	-	🟩		🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	-	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	-	-	🟩	-	-	-	-	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩		🟩	
PCB
PCB 28	7012-37-5	17	ng/l	2011 2014	-	-	-		-	-		🟩	-	-	-	-				-	-	-	-	-	-	-	-	-	-	-	-	🟩	-	-	🟩	🟩	-	-	-	-	-	-	-	< 10	< 10	-	-	-	-	-	-	-								
PCB 52	35693-99-3	18	ng/l	2011 2014	-	-	-		-	-		🟩	-	-	-	-				-	-	-	-	-	-	-	-	-	-	-	-	🟩	-	-	🟩	🟩	-	-	-	-	-	-	-	< 10	< 10	-	-	-	-	-	-	-								
PCB 101	37680-73-2	19	ng/l	2011 2014	-	-	-		-	-		🟩	-	-	-	-				-	-	-	-	-	-	-	-	-	-	-	-	🟩	-	-	🟩	🟩	-	-	-	-	-	-	-	< 10	< 10	-	-	-	-	-	-	-								
PCB 118	31508-00-6	20	ng/l	2011 2014	-	-	-		-	-	-	🟩	-	-	-	-				-	-	-	-	-	-	-	-	-	-	-	-	🟩	-	-	🟩	🟩	-	-	-	-	-	-	-	< 10	< 10	-	-	-	-	-	-	-								
PCB 138	35065-28-2	21	ng/l	2011 2014	-	-	-		-	-		🟩	-	-	-	-				-	-	-	-	-	-	-	-	-	-	-	-	🟩	-	-	🟩	🟩	-	-	-	-	-	-	-	< 10	< 10	-	-	-	-	-	-	-								
PCB 153	35065-27-1	22	ng/l	2011 2014	-	-	-		-	-		🟩	-	-	-	-				-	-	-	-	-	-	-	-	-	-	-	-	🟩	-	-	🟩	🟩	-	-	-	-	-	-	-	< 10	< 10	-	-	-	-	-	-	-								
PCB 180	28655-71-2	23	ng/l	2011 2014	-	-	-		-	-		🟩	-	-	-	-				-	-	-	-	-	-	-	-	-	-	-	-	🟩	-	-	🟩	🟩	-	-		-	-	-	-	< 10	< 10	-	-	-	-	-	-	-								
PCB 28 in suspended matter	7012-37-5		µg/kg	2011 2014	-	-	-		🟩	🟩	-	🟩	🟩	🟩	🟩	🟩	🟨	🟨	🟨	🟩	🟩	🟩	🟩	🟩	-	-	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	-	🟩	🟩	🟩	🟩	🟩	🟩	-	-	-	🟩	🟩	🟩	🟩	🟩	🟩		🟩	🟩	-	🟩		-	
PCB 52 in suspended matter	35693-99-3		µg/kg	2011 2014	-	-	-		🟩	🟩	-	🟩	🟩	🟩	🟩	🟩	🟨	🟨	🟨	🟩	🟩	🟩	🟩	🟩	-	-	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	-	🟩	🟩	🟩	🟩	🟩	🟩	-	-	-	🟩	🟩	🟩	🟩	🟩	🟩		🟩	🟩	-	🟩		-	
PCB 101 in suspended matter	37680-73-2		µg/kg	2011 2014	-	-	-		🟩	🟩	-	🟩	🟩	🟩	🟩	🟩	🟨	🟨	🟨	🟩	🟩	🟩	🟩	🟩	-	-	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	-	🟩	🟩	🟩	🟩	🟩	🟩	-	-	-	🟩	🟩	🟩	🟩	🟩	🟩		🟩	🟩	-	🟩		-	
PCB 118 in suspended matter	31508-00-6		µg/kg	2011 2014	-	-	-		🟩	🟩	-	🟩	🟩	🟩	🟩	🟩	🟨	🟨	🟨	🟩	🟩	🟩	🟩	🟩	-	-	-	🟩	-	🟩	🟩	🟩	🟩	🟩	🟩	🟩	-	🟩	🟩	🟩	🟩	🟩	🟩	-	-	-	🟩	🟩	🟩	🟩	🟩	🟩		🟩	🟩	-	🟩		-	
PCB 138 in suspended matter	35065-28-2		µg/kg	2011 2014	-	-	-		🟩	🟩	-	🟩	🟩	🟩	🟩	🟩	🟨	🟨	🟨	🟩	🟩	🟩	🟩	🟨	-	-	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	-	🟩	🟩	🟩	🟩	🟩	🟩	-	-	-	🟩	🟨	🟩	🟩	🟩	🟩		🟩	🟩	-	🟩		-	
PCB 153 in suspended matter	35065-27-1		µg/kg	2011 2014	-	-	-		🟩	🟩	-	🟩	🟩	🟩	🟩	🟩	🟨	🟨	🟨	🟩	🟩	🟩	🟩	🟨	-	-	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	-	🟩	🟩	🟩	🟩	🟩	🟩	-	-	-	🟩	🟨	🟩	🟩	🟨	🟩		🟩	🟩	-	🟨		-	
PCB 180 in suspended matter	28655-71-2		µg/kg	2011 2014	-	-	-		🟩	🟩	-	🟩	🟩	🟩	🟩	🟩	🟨	🟨	🟨	🟩	🟩	🟩	🟩	🟨	-	-	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	-	🟩	🟩	🟩	🟩	🟩	🟩	-	-	-	🟩	🟨	🟩	🟩	🟩	🟩		🟩	🟩	-	🟩		-	
Organo-tin compounds
Dibutyltin-cation	14488-53-0		µg/l	2011	🟩	🟩	-		-	-	-	🟩	-	🟩	-	🟩	🟩	🟩	🟩	-	-	-	-	-	-	-	-	-	-	-	-	🟩	-	-	🟩	🟩	-	-	-	-	🟩	-	-	<0,001	<0,001	-	-	🟩	-	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩		🟩	
Calculation based on suspended matter:
PCB
PCB 28	7012-37-5		ng/l	2011 2014	-	-	-		-	-	-	🟩	-	-	-	-				-	-	-	-	-	-	-	-	-	-	-	-	🟩	-	-	🟩	🟩	-	-	-	-	🟩	-	-	-	-	-	-	-	-	-	-	-								
PCB 52	35693-99-3		ng/l	2011 2014	-	-	-		-	-	-	🟩	-	-	-	-				-	-	-	-	-	-	-	-	-	-	-	-	🟩	-	-	🟩	🟩	-	-	-	-	🟩	-	-	-	-	-	-	-	-	-	-	-								
PCB 101	37680-73-2		ng/l	2011 2014	-	-	-		-	-	-	🟩	-	-	-	-				-	-	-	-	-	-	-	-	-	-	-	-	🟩	-	-	🟩	🟩	-	-	-	-	🟩	-	-	-	-	-	-	-	-	-	-	-								
PCB 118	31508-00-6		ng/l	2011 2014	-	-	-		-	-	-	🟩	-	-	-	-				-	-	-	-	-	-	-	-	-	-	-	-	🟩	-	-	🟩	🟩	-	-	-	-	🟩	-	-	-	-	-	-	-	-	-	-	-								
PCB 138	35065-28-2		ng/l	2011 2014	-	-	-		-	-	-	🟩	-	-	-	-				-	-	-	-	-	-	-	-	-	-	-	-	🟩	-	-	🟩	🟩	-	-	-	-	🟩	-	-	-	-	-	-	-	-	-	-	-								
PCB 153	35065-27-1		ng/l	2011 2014	-	-	-		-	-	-	🟩	-	-	-	-				-	-	-	-	-	-	-	-	-	-	-	-	🟩	-	-	🟩	🟩	-	-	-	-	🟩	-	-	-	-	-	-	-	-	-	-	-								
PCB 180	28655-71-2		ng/l	2011 2014	-	-	-		-	-	-	🟩	-	-	-	-				-	-	-	-	-	-	-	-	-	-	-	-	🟩	-	-	🟩	🟩	-	-	-	-	🟩	-	-	-	-	-	-	-	-	-	-	-								
Measured in suspended matter:
Heavy metals and metalloids
As	7440-38-2		mg/kg	2011 2014	-	-	-		🟩	🟩	-	🟩	🟩	🟩	🟩	🟩				🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟨	🟩	🟩	🟩	🟩	🟩	🟩	-	🟩	🟩	🟩	🟩	🟩	🟩	-	-	-	🟩	🟩	🟨	🟩	🟩	🟩								
Cr III+VI	n.a.		mg/kg	2011 2014	-	-	-		🟩	🟩	-	🟩	🟩	🟩	🟩	🟩				🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	-	🟩	🟩	🟩	🟩	🟩	🟩	-	-	-	🟩	🟩	🟩	🟩	🟩	🟩								
Cu	7440-50-8		mg/kg	2011 2014	-	-	-		🟩	🟩	-	🟩	🟩	🟩	🟩	🟩				🟩	🟩	🟩	🟩	🟨	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟨	-	🟩	🟩	🟩	🟩	🟩	🟩	-	-	-	🟩	🟨	🟩	🟨	🟨	🟩								
Zn	7440-66-6		mg/kg	2011 2014	-	-	-		🟩	🟩	-	🟩	🟩	🟩	🟩	🟩				🟩	🟩	🟩	🟩	🟨	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟨	🟩	-	🟩	🟩	🟩	🟩	🟩	🟩	-	-	-	🟨	🟨	🟨	🟨	🟨	🟨								
Organo-tin compounds
Dibutyltin-cation	14488-53-0		µg/kg	2011	-	-	-		🟩	🟩	-	🟩	🟩	🟩	🟩	🟩				🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	-	🟩	-	-	🟩	-	-	-	-	-	🟩	🟩	🟩	🟩	🟩	🟩								
In excess of one or more EQS for substances relevant for the Rhine																🟨	🟨	🟨					🟨						🟨					🟨	🟨								🟨			🟨	🟨	🟨	🟨	🟨	🟨	🟨		🟨	🟨	🟨		🟨	
Below all EQS for substances relevant for the Rhine					🟩	🟩	🟩		🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩				🟩	🟩	🟩	🟩		🟩	🟩	🟩	🟩	🟩		🟩	🟩	🟩	🟩			🟩	🟩	🟩	🟩	🟩	🟩	🟩		🟩	🟩								🟩						

Annex 3: Environmental quality standards for the Rhine (EQS Rhine)* – scientific status 2007 – for substances relevant for the Rhine according to CC 17-03 rev. 09/10 October 2003**

Substance	**AA-EQS Rhine Inland surface waters according to WFD (in µg/l)**	**PMC-EQS Rhine Inland surface waters according to WFD (in µg/l)**	**EQS Rhine inland surface waters “Water for human consumption” (98/83/EC) 5) (in µg/l)**	**AA-EQS Rhine Coastal and transitional waters according to WFD (in µg/l)**	**Acceptable maximum concentration EQS Rhine Coastal and transitional waters according to WFD (in µg/l)**
Arsenic1)	BC2) + 0.5	BC2) + 8.0	10	BC2) + 0.6	BC2) + 1.1
Chromium1)	BC2) + 3.4	-6)	50	BC2) + 0.6	-6)
Zinc1)	BC2) + 7.8	BC2) + 15.6	-	BC2) + 3	-
Bentazone	73	450	0.1	7.3	45
4-chloroaniline	0.22	1.2	0.14)	0.057	0.12
Chlorotolurone	0.4	2.3	0.1	0.04	0.23
Dichlorvos	0.0006	0.0007	0.1	0.00006	0.00007
Dichloroprop	1.0	7.6	0.1	0.13	0.76
Dimethoate	0.07	0.7	0.1	0.07	0.7
Mecoprop	18	160	0.1	1.8	16
MCPA	1.4	15	0.1	0.14	1.5
Dibutyl-tin compounds (related to cation)	0.09	-	-	0.09	-
Ammonium-N3)	Depending on temperature and pH; see table a	Depending on temperature and pH; see table b	390	-	-
PCB 28, 52, 101, 118, 138, 153	Wait for termination of work on EU level.	Wait for termination of work on EU level.	-	Wait for termination of work on EU level.	Wait for termination of work on EU level.

EQS Rhine = Environmental quality standard Rhine; PMC = permissible maximum concentration; AA = annual average

* Legally determined as concentration values in the Netherlands

** ICPR target values for the main stream (see www.iksr.org: ICPR document no. 159) continue to apply. On the long term, concentrations may not significantly rise (interdiction of deterioration). More exacting national standards are not concerned. There is no EQS-Rhine for copper.

1) The EQS concern the dissolved share (filtered sample); for chromium they concern the sum of chromium (III and VI)

2) BC = background concentration
Arsenic: BC = 1 µg/l (Rhine and tributaries)

Chromium (sum Cr III and VI): BC = 0.38 µg/l (Rhine and tributaries), ca. 0.02 – 0.5 µg/l (other waters)
Zinc: BC = 3 µg/l (Rhine and tributaries), 1 µg/l other waters

(3) See substance data sheet with corrected values for pH and temperature

(4) 4-chloroaniline is not only a chemical substance applied in industry but also a pesticide degradation product.

(5) For surface water bodies used for drinking water production, the maximum value of the directive "Water for human consumption" (98/83/EC) must be strived for, if this value is below the EQS-Rhine value according to WFD derived for inland surface water bodies.

(6) The derived value cannot be applied. The AA-EQS Rhine value confers sufficient protection.

Addendum to footnote 3: Substance data sheet with corrected values for pH and temperature

Table a.
AA-EQS Rhine inland surface waters according to WFD NH_3-N,
transposed into total ammonium nitrogen (NH_4-N + NH_3-N) in mg/l

		Temperature						
		0	**5**	**10**	**15**	**20**	**25**	**30**
pH	**5.5**	157.467	104.122	69.862	47.529	32.763	22.869	16.153
	6	49.798	32.929	22.095	15.033	10.363	7.237	5.111
	6.5	15.750	10.416	6.990	4.757	3.280	2.291	1.619
	7	4.984	3.297	2.213	1.507	1.040	0.727	0.515
	7.5	1.579	1.045	0.703	0.479	0.332	0.233	0.166
	7.6	1.255	0.831	0.559	0.382	0.264	0.186	0.132
	7.7	0.998	0.661	0.445	0.304	0.211	0.148	0.106
	7.8	0.793	0.526	0.354	0.242	0.168	0.119	0.085
	7.9	0.631	0.419	0.282	0.193	0.135	0.095	0.068
	8	0.502	0.333	0.225	0.154	0.108	0.076	0.055
	8.1	0.400	0.266	0.180	0.123	0.086	0.062	0.045
	8.2	0.318	0.212	0.143	0.099	0.069	0.050	0.036
	8.3	0.254	0.169	0.115	0.079	0.056	0.040	0.030
	8.4	0.202	0.135	0.092	0.064	0.045	0.033	0.024
	8.5	0.162	0.108	0.074	0.052	0.037	0.027	0.020
	9	0.054	0.037	0.026	0.019	0.014	0.011	0.009

Greyed out: exceeds of the imperative value of the Directive for Fish Waters
of 0.778 mg/l NH_4-N + NH_3-N resp. 1 mg/l ammonium

Table b.
AA-EQS Rhine inland surface waters according to WFD NH_3-N,
transposed into total ammonium nitrogen (NH_4-N + NH_3-N) in mg/l

		Temperature						
		0	**5**	**10**	**15**	**20**	**25**	**30**
pH	**5.5**	314.950	208.243	139.724	95.057	65.526	45.737	32.306
	6	99.597	65.858	44.190	30.065	20.727	14.469	10.222
	6.5	31.501	20.838	13.980	9.513	6.560	4.581	3.238
	7	9.967	6.593	4.426	3.014	2.080	1.454	1.030
	7.5	3.157	2.091	1.405	0.959	0.663	0.465	0.331
	7.6	2.510	1.662	1.118	0.763	0.529	0.371	0.265
	7.7	1.995	1.322	0.890	0.608	0.422	0.297	0.212
	7.8	1.587	0.780	0.708	0.485	0.337	0.237	0.170
	7.9	1.262	0.979	0.564	0.387	0.269	0.190	0.137
	8	1.004	0.667	0.450	0.309	0.215	0.153	0.110
	8.1	0.799	0.535	0.359	0.247	0.173	0.123	0.089
	8.2	0.637	0.424	0.287	0.198	0.139	0.099	0.073
	8.3	0.507	0.338	0.230	0.159	0.112	0.081	0.059
	8.4	0.405	0.270	0.184	0.128	0.091	0.066	0.049
	8.5	0.323	0.216	0.148	0.103	0.074	0.054	0.040
	9	0.108	0.074	0.052	0.038	0.029	0.023	0.018

Greyed out: exceeds of the imperative value of the Directive for Fish Waters
0.778 mg/l NH_4-N + NH_3-N resp. 1 mg/l ammonium

Annex 4: Environmental quality standards for priority substances and certain other pollutants

AA: Annual average; PMC: permissible maximum concentration; unit [µg/l]

			Annex I Directive 2008/105/EC				Annex II Directive 2013/39/EC				
Number	**Name of the substance**	**CAS Number[i]**	**AA-EQS[ii] Inland surface waters[iii]**	**AA-EQS[ii] Other surface waters**	**PMC-EQS[iv] Inland surface waters[iii]**	**PMC-EQS[iv] Other surface waters**	**AA-EQS Inland surface waters**	**AA-EQS Other surface waters**	**PMC-EQS Inland surface waters**	**PMC-EQS Other surface waters**	**EQS Biota [V] µg/kg FW**
1	Alachlor	15972-60-8	0.3	0.3	0.7	0.7	0.3	0.3	0.7	0.7	
2	Anthracene	120-12-7	0.1	0.1	0.4	0.4	0.1	0.1	0.1	0.1	
3	Atrazine	1912-24-9	0.6	0.6	2.0	2.0	0.6	0.6	2.0	2.0	
4	Benzene	71-43-2	10	8	50	50	10	8	50	50	
5	Brominated diphenyl ethers[vi]	32534-81-9	0.0005	0.0002	not applicable	not applicable	-	-	0.14	0.014	0.0085
6	Cadmium and compounds (according to water hardness) [vi]	7440-43-9	≤ 0.08 (class 1) 0.08 (class 2) 0.09 (class 3) 0.15 (class 4) 0.25 (class 5)	0.2	≤ 0.45 (class 1) 0.45 (class 2) 0.6 (class 3) 0.9 (class 4) 1.5 (class 5)		≤ 0.08 (class 1) 0.08 (class 2) 0.09 (class 3) 0.15 (class 4) 0.25 (class 5)	0.2	≤ 0.45 (class 1) 0.45 (class 2) 0.6 (class 3) 0.9 (class 4) 1.5 (class 5)	≤ 0.45 (class 1) 0.45 (class 2) 0.6 (class 3) 0.9 (class 4) 1.5 (class 5)	
6b	Carbon tetrachloride[viii]	56-23-5	12	12	not applicable	not applicable	12	12	not applicable	not applicable	
7	C10-13-chloroalkanes (SCCP)	85535-84-8	0.4	0.4	1.4	1.4	0.4	0.4	1.4	1.4	
8	Chlorofenvinphos	470-90-6	0.1	0.1	0.3	0.3	0.1	0.1	0.3	0.3	
9	Chloropyriphos	2921-88-2	0.03	0.03	0.1	0.1	0.03	0.03	0.1	0.1	
9b	Cyclodien pesticides: Aldrin [viii] Dieldrin [viii] Endrin [viii] Isodrin [viii]	 309-00-2 60-57-1 72-20-8 465-73-6	Σ=0.01	Σ=0.005	not applicable	not applicable	Σ=0.01	Σ=0.005	not applicable	not applicable	
9ter	Total DDT[viii, ix] p.p.'-DDT [viii]	not applicable 50-29-3	0.025 0.01	0.025 0.01	not applicable not applicable	not applicable not applicable	0.025 0.01	0.025 0.01	not applicable not applicable	not applicable not applicable	
10	1.2-dichlorethane	107-06-2	10	10	not applicable	not applicable	10	10	not applicable	not applicable	
11	Dichloromethane (methylene chloride)	75-09-2	20	20	not applicable	not applicable	20	20	not applicable	not applicable	
12	bis(2-ethylhexyl)phthalate (DEHP)	117-81-7	1.3	1.3	not applicable	not applicable	1.3	1.3	not applicable	not applicable	
13	Diurone	330-54-1	0.2	0.2	1.8	1.8	0.2	0.2	1.8	1.8	
14	Endosulfan	115-29-7	0.005	0.0005	0.01	0.004	0.005	0.0005	0.01	0.004	
15	Fluoranthene	206-44-0	0.1	0.1	1	1	0.0063	0.0063	0.12	0.12	30
16	Hexachlorobenzene	118-74-1	0.01[x]	0.01[x]	0.05	0.05	-	-	0.05	0.05	10
17	Hexachlorbutadiene	87-68-3	0.1[x]	0.1[x]	0.6	0.6	-	-	0.6	0.6	55
18	Hexachlorocyclohexane	608-73-1	0.02	0.002	0.04	0.02	0.02	0.002	0.04	0.02	
19	Isoproturon	34123-59-6	0.3	0.3	1.0	1.0	0.3	0.3	1.0	1.0	
20	Lead and lead compounds	7439-92-1	7.2	7.2	not applicable	not applicable	1.2[xi]	1.3	14	14	
21	Mercury and mercury compounds	7439-97-6	0.05[x]	0.05[x]	0.07	0.07	-	-	0.07	0.07	20
22	Naphthalene	91-20-3	2.4	1.2	not applicable	not applicable	2	2	130	130	
23	nickel and nickel compounds	7440-02-0	20	20	not applicable	not applicable	4[xi]	8.6	34	34	
24	Nonylphenol (4-nonylphenol)	104-40-5	0.3	0.3	2.0	2.0	0.3	0.3	2.0	2.0	
25	Octylphenol (4-(1,1',3,3'-tetramethylbutyl)-phenol))	140-66-9	0.1	0.01	not applicable	not applicable	0.1	0.01	not applicable	not applicable	
26	pentachlorobenzene	608-93-5	0.007	0.0007	not applicable	not applicable	0.007	0.0007	not applicable	not applicable	
27	Pentachlorophenol	87-86-5	0.4	0.4	1	1	0.4	0.4	1	1	
28	Polycyclic aromatic hydrocarbons (PAH) [xii]	not applicable	not applicable	not applicable	not applicable	not applicable	not applicable	not applicable	not applicable	not applicable	
	Benzo(a)pyrene	50-32-8	0.05	0.05	0.1	0.1	0.00017	0.00017	0.27	0.027	5
	Benzo(b)fluoranthene	205-99-2	Σ=0,03	Σ=0,03	not applicable	not applicable	[xiii]	[xiii]	0.017	0.017	[xiii]
	Benzo(k)fluoranthene	207-08-9					[xiii]	[xiii]	0.017	0.017	[xiii]
	Benzo(g,h,i)perylene	191-24-2	Σ=0.03	Σ=0.03			[xiii]	[xiii]	0.0082	0.00082	[xiii]
	Indeno(1,2,3-cd)pyrene	193-39-5			not applicable	not applicable	[xiii]	[xiii]	not applicable	not applicable	[xiii]
29	Simazine	122-34-9	1	1	4	4	1	1	4	4	
29b	Tetrachloroethylene[viii]	127-18-4	10	10	not applicable	not applicable	10	10	not applicable	not applicable	
29ter	Trichloroethylene [viii]	79-01-6	10	10	not applicable	not applicable	10	10	not applicable	not applicable	
30	Tributyltin compounds (tributyltin cation)	36643-28-4	0.0002	0.0002	0.0015	0.0015	0.0002	0.0002	0.0015	0.0015	

			Annex I Directive 2008/105/EC				Annex II Directive 2013/39/EC				
Number	**Name of the substance**	**CAS Number[i]**	**AA-EQS[ii] Inland surface waters[iii]**	**AA-EQS[ii] Other surface waters**	**PMC-EQS[iv] Inland surface waters[iii]**	**PMC-EQS[iv] Other surface waters**	**AA-EQS Inland surface waters**	**AA-EQS Other surface waters**	**PMC-EQS Inland surface waters**	**PMC-EQS Other surface waters**	**EQS Biota [V] µg/kg FW**
31	Trichlorobenzenes	12002-48-1	0.4	0.4	not applicable	not applicable	0.4	0.4	not applicable	not applicable	
32	Trichloromethane	67-66-3	2.5	2.5	not applicable	not applicable	2.5	2.5	not applicable	not applicable	
33	Trifluralin	08/09/1582	0.03	0.03	not applicable	not applicable	0.03	0.03	not applicable	not applicable	
34	Dicofol	115-32-2					0.0013	0.000032	not applicable	not applicable	33
35	Perfluorooctanesulfonic acid and derivatives (PFOS)	1763-23-1					0.00065	0.00013	36	7.2	9.1
36	Quinoxyfen	124495-18-7					0.15	0.015	2.7	0.54	
37	Dioxins and dioxin-like compounds								not applicable	not applicable	Sum PCDD + PCDF + PCB-DL 0,0065 µg.kg –1 TEQ [xiv]
38	Aclonifen	74070-46-5					0.12	0.012	0.12	0.012	
39	Bifenox	42576-02-3					0.012	0.0012	0.04	0.004	
40	Cybutryne	28159-98-0					0.0025	0.0025	0.016	0.016	
41	Cypermethrin	52315-07-8					0.00008	0.000008	0.0006	0.00006	
42	Dichlorvos	62-73-7					0.0006	0.00006	0.0007	0.00007	
43	Hexabromcyclododecan (HBCDD)						0.0016	0.0008	0.5	0.05	167
44	Heptachlorine and heptachlor epoxide	76 (-44-8) 1024-57-3					0.0000002	0.00000001	0.0003	0.00003	$6.7\ 10^{-3}$
45	Terbutryne	886-50-0					0.065	0.0065	0.34	0.34	

[i] CAS: Chemical Abstracts Service.

[ii] This parameter corresponds to the environmental quality standard (EQS) expressed as annual average (AA-EQS). If nothing else is indicated it applies to the total concentration of all isomers.

[iii] Surface water bodies comprise rivers and lakes as well as connected artificial or heavily modified water bodies.

[iv] This parameter corresponds to the environmental quality standard expressed as permissible maximum concentration (PMC-EQS). If the PMC-EQS is indicated as "not applicable", the AA-EQS values also apply as sufficient level of protection during short pollution peaks during continuous discharges, as they are distinctly lower than values determined on the basis of acute toxicity.

[v] If not otherwise indicated, the biota EQS concerns fish. An alternative biota taxon or another matrix may be monitored instead, as long as the applied EQS offers an equivalent level of protection. For substances with the numbers 15 (fluoranthene) and 28 (PAH) the biota EQS refers to crustaceans and molluscs. The monitoring of fluoranthene and PAH in fish is not suitable for the classification of the chemical status. For substances with the number 37 (dioxins and dioxin-like compounds) the biota EQS refers to fish, crustaceans and molluscs; corresponds to section 5.3 of the Annex to the Commission Regulation (EU) No. 1259/2011 amending Regulation (EC) No. 1881/2006 as regards maximum levels for dioxins, dioxin-like PCBs and non dioxin-like PCBs in foodstuffs (OJ L320 of 3 December 2011, p. 18).

[vi] For the group of priority substances belonging to the brominated diphenylethers (no. 5) listed in Decision Nr. 2455/2001/EC an environmental quality standard is only determined for the congeners of the numbers 28, 47, 99, 100, 153 and 154.

[vii] For cadmium and cadmium compounds (no. 6) the EQS depends on water hardness presented in five categories (class 1: <40 mg $CaCO_3$/l, class 2: 40 to <50 mg $CaCO_3$/l, class 3: 50 to <100 mg $CaCO_3$/l, class 4: 100 to <200 mg $CaCO_3$/l, and class 5: ≥200 mg $CaCO_3$/l).

[viii] This is not a priority substance but a substance belonging to the other pollutants for which environmental quality standards are identical to those determined in legal provisions applicable before 13 January 2009.

[ix] Total DDT comprises the sum of isomers 1,1,1-trichloro-2,2-bis-(p-chlorophenyl)ethane (CAS No. 50-29-3; EU No. 200-024-3), 1,1,1-trichloro-2(o-chlorophenyl)-2-(p-chlorophenyl)ethane (CAS No. 789-02-6; EU No. 212-332-5), 1,1-Dichloro-2,2-bis-(p-chlorophenyl)ethylene (CAS No. 72-55-9; EU-No. 200-784-6) and 1,1-dichloro-2,2-bis-(p-chlorophenyl)ethane (CAS No. 72-54-8; EU No. 200-783-0).

[x] If a Member State does not apply the environmental quality standard for biota, it introduces more stringent environmental quality standards for water, so that the same level of protection is achieved as would have been the case when applying the environmental quality standards for biota determined in Article 3, Paragraph 2 of this Directive. The Member State informs the Commission and the other Member States by through the Committee addressed in Article 21 of the Directive 200/60/EC about the reasons for why this approach is chosen and the alternative environmental quality standards determined for water as well as the data and methods for deriving the alternative environmental quality standards and the category of surface waters for which they are applicable.

[xi] These EQS refer to biologically available concentrations of the substances

[xii] As far as the group of polycyclic aromatic hydrocarbons (PAH) (Nr. 28) is concerned, each individual environmental quality standard applies. That means that the environmental quality standard for benzo(a)pyrene and the environmental quality standard for the sum of benzo(b)fluoranthene and benzo(k)fluoranthene and the environmental quality standard for the sum of benzo(g,h,i)perylene and indeno(1,2,3-cd)pyrene must be respected.

[xiii] For the group of polycyclic aromatic hydrocarbons (PAH) (no. 28) the biota EQS and the corresponding AA-EQS in water refers to concentrations of benzo(a)pyrene as toxicity basis. Benzo(a)pyrene can be considered as marker for the other PAH; therefore, only benzo(a)pyrene must be monitored in comparison to the biota EQS and the corresponding AA-EQS in water.

[xiv] PCDD: polychlorinated dibenzoparadioxins; PCDF: polychlorinated dibenzofurans; PCB-DL: dioxin-like polychlorinated biphenyls; TEQ: Toxicity equivalents according to the toxic equivalency factors of the World Health Organization of 2005."

Legend:

red: Modified EQS or new substances and new EQS

Annex 5: Assessment results for the monitoring stations incorporated in the “Chemistry” surveillance monitoring programme according to WFD

Priority substances

Directive 2008/105/EC, modified by Directive 2013/39/EU of the European Parliament and the Council for priority substances in the area of water policy

State: December 2015

Classification legend

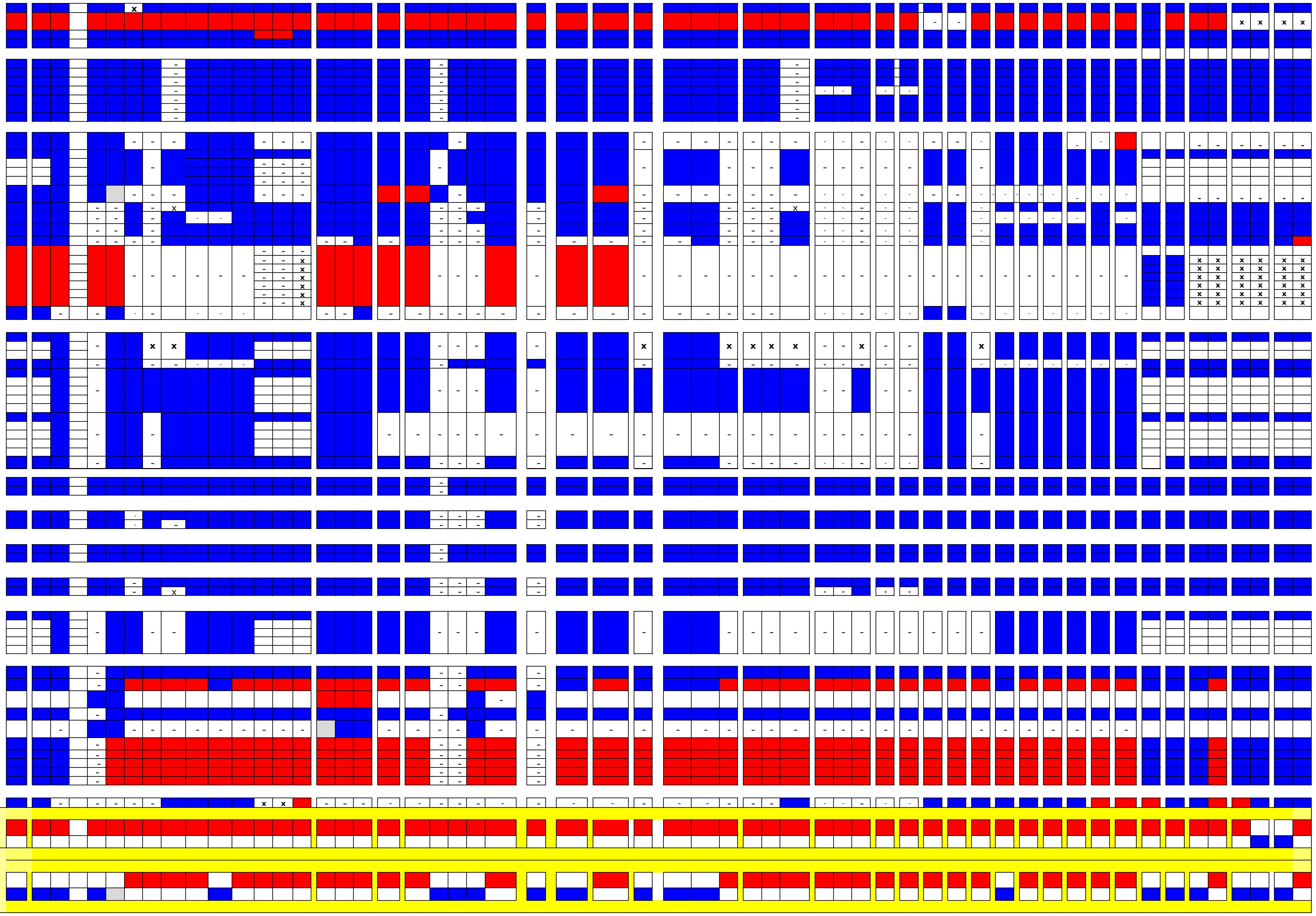
🟥	In excess of AA-EQS
🟦	Below AA-EQS
▨	EQS biota respected, but EQN exceeded in the water phase
X	no decision possible because of too high limit of determination
-	no measurements available

Legend for monitoring stations

☐	Monitoring stations and inland surface waters
▨	Monitoring stations at “other surface waters”

River	Monitoring station no.	Name of monitoring station
Ach near Brege	61	Fussach
Rhine	60	Fussach/Alpine Rhir
	5	Öhningen
	1	Rekingen
	2	Weil am Rhein
	7	Karlsruhe/Lauterbo
	11	Worms
	12	Mainz
	13	Koblenz
	32	Bad Honnef
	34	Düsseldorf-Flehe
	35	Bimmen
	41	Lobith
	43	Kampen
	42	Maassluis
Neckar	8	Deizisau
	9	Kochendorf
	10	Mannheim
Weschnitz	31	Biblis-Wattenheim
Schwarzbach	28	Trebur-Astheim
Main	54	Hallstadt
	24	Erlabrunn
	23	Kahl a. Main
	25	Bischofsheim
Regnitz	55	Hausen
Kinzig	26	Hanau
Nidda	27	Nied
Nahe	19	Dietersheim
Lahn	29	Solms-Oberbiel
	30	Limburg
	20	Lahnstein
Moselle	15	Palzem
	17	Fankel
	18	Koblenz
Saar	21	Saarbrücken
	22	Fremersdorf
	14	Kanzem
Blies	52	Reinheim
Nied	53	Niedaltdorf
Alzette	56	Ettelbruck
Wiltz	57	Kautenbch
Sauer	16	Wasserbillig
Sieg	36	Menden
Wupper	37	Opladen
Erft	40	Epinghoven
Ruhr	38	Mülheim
Emscher	33	Mouth R. Emscher
Lippe	39	Wesel
Vecht	51	Vecht stuw Vechter
Lake IJssel	44	Vrouwezand
Wadden Sea	45	Doove Balg West
	46	Dantziggat
Dutch coast	47	Noordwijk 2
	48	Noordwijk 10
Wadden Sea	49	Boomkensdiep
	50	Terschelling 10

Substance	Value (WFD-Codelist)	CAS	Unit	No. WFD	AA-EQS WFD	AA-EQS WFD
chemical parameter (chemical status)					**Inland surface waters**	**Other surface waters**
Heavy metals and metalloids (solute)						
Cd sol.	39	7440-43-9	µg/l	6	<= 0,08-0,25	0,2
Hg	56	7439-97-6	µg/kg wet weight	21	20 (biota)*	20 (biota)*
Ni sol.	58	7440-02-0	µg/l	23	4**	8.6**
Pb sol.	55	7439-92-1	µg/l	20	1.2**	1.3**
Volatile hydrocarbons						
Dichloromethane	44	75-09-2	µg/l	11	20	20
Trichloromethane	76	67-66-3	µg/l	32	2,5	2,5
1,2-dichlorethane	43	107-06-2	µg/l	10	10	10
benzene	37	71-43-2	µg/l	4	10	8
Tetrachloromethane	26	56-23-5	µg/l	6a	12	12
trichloroethene	32	79-01-6	µg/l	29b	10	10
tetrachloroethene	33	127-18-4	µg/l	29a	10	10
Non-volatile hydrocarbons						
Hexachlorbutadiene	51	87-68-3	µg/kg wet weight	17	55 (biota)	55 (biota)
Sum trichlorobenzenes	74	12002-48-1	µg/l	31	S=0.4	S=0.4
1.2.3-trichlorobenzene	224	87-61-6				
1.2.4-trichlorobenzene	75	120-82-1				
1.3.5-trichlorobenzene	248	108-70-3				
Hexachlorobenzene	50	118-74-1	µg/kg wet weight	16	10 (biota)	10 (biota)
Pentachlorobenzene	63	608-93-5	µg/l	26	0,007	0,0007
4-nonylphenol	59	84852-15-3	µg/l	24	0,3	0,3
Para-tert.-octylphenol	62	140-66-9	µg/l	25	0,1	0,01
Bis(ethylhexyl)phthalate (DEHP)	45	117-81-7	µg/l	12	1,3	1,3
Brominated diphenyl ethers	38	32534-81-9	µg/kg wet weight	5	S=0.0085 (biota)	S=0.0085 (biota)
BDE 28	299	41318-75-6				
BDE 47	300	5436-43-1				
BDE 99	301	60348-60-9				
BDE 100	302	189084-64-8				
BDE 153	303	68631-49-2				
BDE 154	304	207122-15-4				
C_{10-13}-Chloroalkanes	40	207122-15-4	µg/l	7	0,4	0,4
Chloropesticides						
Endosulfan	47	115-29-7	µg/l	14	S=0.005	S=0.0005
a-endosulfan	48	959-98-8				
b-endosulfan	90	33213-65-9				
Pentachlorophenol	64	87-86-5	µg/l	27	0,4	0,4
Sum HCH (a- to d-HCH)	52	608-73-1	µg/l	18	S=0.02	S=0.002
g-HCH (lindane)	53	58-89-9				
a-HCH	305	319-84-6				
b-HCH	306	33213-65-9				
d-HCH	307	319-86-8				
Total DDT	310	n.a.	µg/l	9b	S=0.025	S=0.025
p,p'-DDD	311	72-54-8				
p,p'-DDE	312	72-55-9				
o,p'-DDT	313	789-02-6				
p,p′-DDT	27	50-29-3				
p,p′-DDT	27	50-29-3	µg/l	9b	0,01	0,01
Phenylurea derivatives						
Diurone	46	330-54-1	µg/l	13	0,2	0,2
Isoproturon	54	34123-59-6	µg/l	19	0,3	0,3
Phosphorous acid esters						
Chlorofenvinphos	41	470-90-6	µg/l	8	0,1	0,1
Chlorpyrifos (Chlorpyrifos-ethyl)	42	2921-88-2	µg/l	9	0,03	0,03
Triazines						
Atrazine	36	1912-24-9	µg/l	3	0,6	0,6
Simazine	71	122-34-9	µg/l	29	1	1
Other plant protection agents						
Alachlor	34	122-34-9	µg/l	1	0,3	0,3
Trifluralin	77	08/09/1582	µg/l	33	0,03	0,03
drins						
Cyclodien pesticides	314	n.a.	µg/l	9a	S=0.01	S=0.005
Aldrin	28	309-00-2				
Dieldrin	29	60-57-1				
Endrin	30	72-20-8				
Isodrin	31	465-73-6				
PAH						
Anthracene	35	120-12-7	µg/l	2	0,1	0,1
Fluoranthene	49	206-44-0	µg/l	15	0,0063	0,0063
Fluoranthene	49	206-44-0	µg/kg wet weight	15	30 (biota)	30 (biota)
Naphthalene	57	91-20-3	µg/l	22	2	2
Benzo(a)pyrene	66	2320	µg/kg wet weight	28	5 (biota)	5 (biota)
Benzo(a)pyrene	66	2320	µg/l	28	0,00017	0,00017
(1) benzo(b)fluoranthene	67	2301	µg/l	28	See ***)	See ***)
(2) benzo(k)fluoranthene	69	2302	µg/l	28	See ***)	See ***)
(3) benzo(ghi)perylene	68	2310	µg/l	28	See ***)	See ***)
(4) indeno(1.2.3-cd)pyrene	70	2330	µg/l	28	See ***)	See ***)
Organo-tin compounds						
Tributyltin-cation	73	36643-28-4	µg/l	30	0,0002	0,0002
Excess of one or more EQS						
Below all EQS						
Without ubiquitous substances:						
Excess of one or more EQS						
Below all EQS						



Annex 5: Assessment results for the monitoring stations incorporated in the “Chemistry” surveillance monitoring programme according to WFD

Priority substances

Directive 2008/105/EC, modified by Directive 2013/39/EU of the European Parliament and the Council for priority substances in the area of water policy

Classification legend

- 🟥 In excess of AA-EQS
- 🟦 Below AA-EQS
- ▨ EQS biota respected, but EQN exceeded in the water phase
- X no decision possible because of too high limit of determination
- \- no measurements available

Legend for monitoring stations

- ☐ Monitoring stations and inland surface waters
- ▨ Monitoring stations at “other surface waters”

State: December 2015

						River	Ach near Brege	Rhine														Neckar			Weschnitz	Schwarzbach	Main				Regnitz	Kinzig	Nidda	Nahe	Lahn			Moselle			Saar			Blies	Nied	Alzette	Wiltz	Sauer	Sieg	Wupper	Erft	Ruhr	Emscher	Lippe	Vecht	Lake IJssel	Wadden Sea		Dutch coast		Wadden Sea	
						Monitoring station no.	61	60	5	1	2	7	11	12	13	32	34	35	41	43	42	8	9	10	31	28	54	24	23	25	55	26	27	19	29	30	20	15	17	18	21	22	14	52	53	56	57	16	36	37	40	38	33	39	51	44	45	46	47	48	49	50
						Name of monitoring station	Fussach	Fussach/Alpine Rhi	Öhningen	Rekingen	Weil am Rhein	Karlsruhe/Lauterbo	Worms	Mainz	Koblenz	Bad Honnef	Düsseldorf-Flehe	Bimmen	Lobith	Kampen	Maassluis	Deizisau	Kochendorf	Mannheim	Biblis-Wattenheim	Trebur-Astheim	Hallstadt	Erlabrunn	Kahl a. Main	Bischofsheim	Hausen	Hanau	Nied	Dietersheim	Solms-Oberbiel	Limburg	Lahnstein	Palzem	Fankel	Koblenz	Saarbrücken	Fremersdorf	Kanzem	Reinheim	Niedaltdorf	Ettelbruck	Kautenbch	Wasserbillig	Menden	Opladen	Epinghoven	Mülheim	Mouth R. Emscher	Wesel	Vecht stuw Vechter	Vrouwezand	Doove Balg West	Dantziggat	Noordwijk 2	Noordwijk 10	Boomkensdiep	Terschelling 10
Substance	Value (WFD-Codelist)	CAS	**Unit**	**No. WFD**	**AA-EQS WFD**	**AA-EQS WFD**																																																							
Calculation based on suspended matter:																																																													
total DDT		n.a.	**µg/l**	**9b**	**S=0.025**	**S=0.025**			-		🟦	🟦	-	🟦	-	-	-	-	-	-	-	🟦	🟦	🟦	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	🟦	-	-	-	-	-	-	-	-	-	-	-	-	-	-								
p,p'-DDD		72-54-8												🟦					-	-	-																																									
p,p'-DDE		72-55-9												🟦					-	-	-																																									
o,p'-DDT		789-02-6												-					-	-	-																																									
p,p'-DDT		50-29-3												🟦					-	-	-																																									
p,p’-DDT		50-29-3	**µg/l**	**9b**	**0,01**	**0,01**			-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	🟦	-	-	-	🟦	-	-	-	-	-	🟦	-	-	-	🟦	-	-	-	-	-	-	-	-	-	-	-	-	-	-								
Cyclodien pesticides		n.a.	**µg/l**	**9a**	**S=0.01**	**S=0.005**			-		🟦	🟦	-	-	-	-	-	-	-	-	-	🟦	🟦	🟦	-	🟦	-	-	-	🟦	-	-	-	-	-	🟦	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-								
Aldrin		309-00-2																	-	-	-																																									
Dieldrin		60-57-1																	-	-	-																																									
Endrin		72-20-8																	-	-	-																																									
Isodrin		465-73-6																	-	-	-																																									
PAH																																																															
Anthracene		120-12-7	**µg/l**	**2**	**0,1**	**0,1**			-		-	-	-	-	-	🟦	🟦	🟦	-	-	-	-	-	-	🟦	🟦	-	-	-	🟦	-	🟦	🟦	-	🟦	🟦	-	-	-	-	-	-	-	-	-	-	-	-	🟦	🟦	🟦	🟦	🟦	🟦								
Fluoranthene		206-44-0	**µg/l**	**15**	**0,0063**	**0,0063**			-		-	-	-	-	ncerta	ncerta	ncerta	ncerta	-	-	-	-	-	-	🟥	🟥	-	-	-	🟦	-	🟦	🟥	-	🟥	🟥	-	-	-	uncertain	-	-	-	-	-	-	-	-	uncerta	uncerta	uncerta	uncerta	uncerta	uncertain								
Naphthalene		91-20-3	**µg/l**	**22**	**2,4**	**1,2**			-		-	-	-	-	-	🟦	🟦	🟦	-	-	-	-	-	-	🟦	🟦	-	-	-	🟦	-	🟦	🟦	-	🟦	🟦	-	-	-	-	-	-	-	-	-	-	-	-	🟦	🟦	🟦	🟦	🟦	🟦								
Benzo(a)pyrene		50-32-8	**µg/l**	**28**	**0,00017**	**0,00017**			-		🟥	🟥	-	🟥	🟥	🟥	🟥	🟥	-	-	-	🟥	🟥	🟥	🟥	🟥	-	-	-	🟥	-	🟥	🟥	-	🟥	🟥	-	-	-	🟥	-	-	-	-	-	-	-	-	🟥	🟥	🟥	🟥	🟥	🟥								
(1) benzo(b)fluoranthene		205-99-2	**µg/l**	**28**	**See ***)**	**See ***)**			-		🟥	🟥	-	🟥	🟥	🟥	🟥	🟥	-	-	-	🟥	🟥	🟥	🟥	🟥	-	-	-	🟥	-	🟥	🟥	-	🟥	🟥	-	-	-	🟥	-	-	-	-	-	-	-	-	🟥	🟥	🟥	🟥	🟥	🟥								
(2) benzo(k)fluoranthene		207-08-09	**µg/l**	**28**	**See ***)**	**See ***)**					🟥	🟥	-	🟥	🟥	🟥	🟥	🟥	-	-	-	🟥	🟥	🟥	🟥	🟥	-	-	-	🟥	-	🟥	🟥	-	🟥	🟥	-	-	-	🟥	-	-	-	-	-	-	-	-	🟥	🟥	🟥	🟥	🟥	🟥								
(3) benzo(ghi)perylene		191-24-2	**µg/l**	**28**	**See ***)**	**See ***)**			-		🟥	🟥	-	🟥	🟥	🟥	🟥	🟥	-	-	-	🟥	🟥	🟥	🟥	🟥	-	-	-	🟥	-	🟥	🟥	-	🟥	🟥	-	-	-	🟥	-	-	-	-	-	-	-	-	🟥	🟥	🟥	🟥	🟥	🟥								
(4) indeno(1.2.3-cd)pyrene		193-39-5	**µg/l**	**28**	**See ***)**	**See ***)**					🟥	🟥	-	🟥	🟥	🟥	🟥	🟥	-	-	-	🟥	🟥	🟥	🟥	🟥	-	-	-	🟥	-	🟥	🟥	-	🟥	🟥	-	-	-	🟥	-	-	-	-	-	-	-	-	🟥	🟥	🟥	🟥	🟥	🟥								
Organo-tin compounds																																																															
Tributyltin-cation		36643-28-4	**µg/l**	**30**	**0,0002**	**0,0002**			-		🟦	🟦	-	🟦	🟦	🟦	🟦	🟦	-	-	-	🟦	🟦	🟦	🟦	🟦	-	-	-	🟦	-	🟦	🟦	-	🟦	🟦	-	-	-	🟦	-	-	-	-	-	-	-	-	🟦	🟦	🟦	🟦	🟥	🟥								
Excess of one or more EQS									-		🟥	🟥	-	🟥	🟥	🟥	🟥	🟥				🟥	🟥	🟥	🟥	🟥	-	-	-	🟥	-	🟥	🟥	-	🟥	🟥	-	-	-	🟥	-	-	-	-	-	-	-	-	🟥	🟥	🟥	🟥	🟥	🟥								
Below all EQS									-				-														-	-	-		-			-			-	-	-		-	-	-	-	-	-	-	-														
Without ubiquitous substances:																																																														
Excess of one or more EQS									-				-												🟥	🟥	-	-	-		-		🟥	-	🟥	🟥	-	-	-		-	-	-	-	-	-	-	-														
Below all EQS									-		🟦	🟦	-	🟦	uncerta	ncerta	ncerta	ncertain				🟦	🟦	🟦			-	-	-	🟦	-	🟦		-			-	-	-	uncertain	-	-	-	-	-	-	-	-	uncerta	uncerta	uncerta	uncerta	uncerta	uncertain								

*) In the Netherlands the classification is based on the Hg standard for water (7 x 10-5 µg/l) derived from the biota standard.

**) In Germany, the EQS classification for the Management Plan 2015-2021 is done based on values of the Directive 2008/105/EC with an EQS of 20 µg/l for nickel and 7.2 µg/l for lead, as no applicable BLM tool is available.

***) For the group of polycyclic aromatic hydrocarbons (PAH) (no. 28) the biota EQS and the corresponding AA-EQS in water refers to concentrations of benzo(a)pyrene as toxicity basis. Benzo(a)pyrene can be considered as marker for the other PAH; therefore, only benzo(a)pyrene must be monitored in comparison to the biota EQS and the corresponding AA-EQS in water.
The PMC value for benzo[ghi]perylene is out of limits at the monitoring stations Wadden Sea, Dutch Coast and Wadden Sea coast. This overlays the marker function of benzo(a)pyrene based on the AA-EQS so that the final classification for this water body is not good.

🟧 ubiquitous substances

Annex 6: Groundwater quality standards and threshold values

State: December 2015

Parameter			**Quality standards (2006/118/EC)**						
nitrate	NO_3	mg/l	50 (CH: 25)						
sum pesticides		µg/l	0.5						
individual pesticide		µg/l	0.1						
			Threshold values						
			AT	**CH***	**DE**	**FR**	**LU**	**BE/WAL**	**NL**
Conductivity		µS/cm	2250			1000 (20°C) 1100 (25°C)		2100	
Chloride	Cl	mg/l	180	40	250	250	250	150	160**
sulphate	SO_4	mg/l	225	40	240	250	250***	250	
sodium	Na	mg/l		25		200	-	150	
ammonium****	NH_4	mg/l	0.45	0.1 0.5	0.5	0.5	0.5	0.5	
total phosphorus	P	mg/l P_2O_5						1.15	0.1 - 2 mg P/l**
Copper	Cu	µg/l	1800	2		2000		200	
Zinc	Zn	µg/l		5		5000		500	
Arsenic	As	µg/l	9	0.05	10	10	10	10	13.2**
Cadmium	Cd	µg/l	4.5	2	0.5	5	1	5	0.35
Chromium	Cr	µg/l	45	0.01		50		50	
Mercury	Hg	µg/l	0.9	5	0.2	1	1	1	
Nickel	Ni	µg/l	18	5		20		20	20
Lead	Pb	µg/l	9	1	10	10	10	10	7.4
Antimon	Sb	µg/l				5		5	
Cyanure (total)	CN	µg/l		25		50		50	
Oxidability ($KMnO_4$)	Organic substance	mg/l O_2				5		5	
Total organic carbon	TOC	mg/l C		2 (DOC)				6	
Trichloroethylene	C_2HCl_3	µg/l				10			
Tetrachloroethylene	C_2Cl_4	µg/l				10			
Sum trichloroethylene and tetrachloroethylene		µg/l	9		10	10	10		

Geogenic pollution does not result in a bad groundwater status.

* Requirements to groundwater used as drinking water or intended for such use. The values correspond to a positive divergence from the natural state.

** In two groundwater bodies, the threshold value for chloride is not relevant, for total phosphorus 6.9 mg P/l and for arsenic 18.7 µg/l.

*** Depending on the geology, this threshold value may be locally exceeded.

**** CH: Under oxic ratios 0.1 mg/l; under anoxic ration 0.5 mg/l

Annex 7: Master Plan Migratory Fish Rhine - hydro-morphological measures implemented and planned

State: December 2015	**Measures implemented by 2015 or implementation started**	🟩
	Implementation or begin of work by 2018 planned	🟨
	Implementation by 2027 planned	🟧
	Long term phased implementation planned (see Conference of Ministers, Bonn 2007 & Basel 2013)	🟧

* The costs indicated for ongoing and planned measures are largely based on estimates and only partly concern specific measures for migratory fish.

The costs of measures aimed at improving habitat quality have been added to those for the modification of transverse structures in the section of the watercourse concerned.

Country	**Section of the Rhine / tributary system**	**Waters/section, construction/s**	**Improvement upstream migration fish passage: Number of transverse structures**	**Improvement of habitat quality (=x) and further measures**	**Expenses (million Euros)***
NL	Delta Rhine - main stream	Nederrijn/Lek: Construction of 3 fish ladders (Driel: 2001, Amerongen and Hagestein: 2004)	3		9,2
		Nederrijn/Lek: Construction of a fish guidance system at the hydro power plant Amerongen (2016	1		# (see below)
		Afsluitdijk: Implementation of a fish-friendly management of tidal gates and locks (including construction of a freshwater discharge system) at Den Oever and Kornwerderzand (2015)	4		6,9
		Afsluitdijk: Construction of a fish ladder at Den Oever (2015)	1		
		Afsluitdijk: Construction of a fish ladder at Kornwerderzand, possibly as fish migration river (2016-2021)	1		55,0
	Delta Rhine - tributaries	Haringvliet (Maas river system): partial opening of the Haringvliet locks (2018)	1		80,0
		Overijsselse Vecht: Construction of fish ladders (6 of 6: 1987-1994)	6		2,5
	Delta Rhine - Canals	Amsterdam-Rijnkanaal: Implementation of fish-friendly lock management (2010-2015)	2		# (see below)
		Amsterdam-Rijnkanaal: Implementation of fish-friendly lock management (2016-2021)	2		# (see below)
		Nordzeekanaal: Optimization of the fish passage Oranjesluizen (2016-2021)	2		# (see below)
	Delta Rhine - lateral connection of the main stream with regional waters	In the Dutch part of the Delta Rhine work has been carried out at about 90 locations since 2010 (including the above mentioned locations #): Most locations concern measures taken at tributaries (among others at locks and pump stations) in order to restore and improve lateral connections between regional waters and the main stream. Between 2010 and 2015 some 40 measures were implemented. The rest will be carried through after 2015.		x	23,0
				x	(Including #)
				x	
Sum Delta Rhine incl. branches of the Rhine, IJssel, Lake IJssel & Haringvliet (Meuse)			**23**		**176,6**
D-NW	Kalflack	Fishway from the Lower Rhine into the Kalflack at the scooping-bucket elevator at Rhine km 852.4 (at the Emmerich bridge over the Rhine)	1		1,3
	Wupper	Wupper: Upstream continuity in water body for migratory fish from the confluence until km 72.3 is granted. Downstream migration: Need for remediation at approx. 5 locations; tributaries: Morsbach, Gelpe, Eschbach, Wiembach, Murbach	8	Structural improvement	1,5
		Dhünn: River continuity of the water body for migratory fish achieved	4	Structural improvement	0,8
	Sieg	Rheinische Sieg; monitoring station; pilot fish protection installation Unkelmühle: Accomplishment 2012	5	Structural improvement	10,5
		Bröl	2	Structural improvement	0,15
		Agger with Sülz and Naaf	2		0,6
D-RP		Sieg, middle section	6		1
		Sieg, middle section: Weir Hösch, Freusburger Mühle, weir Scheuerfeld (RWE), weir Euteneuen	2		1
		Nister, downstream region (23 km)	8		1,2
		Nister, downstream region (23 km)	1		
		Nister, upstream region (22.5 km)	4		
D-NW		Sieg, upstream region in North Rhine-Westphalia	9		
		Ferndorf, upstream tributary of R. Sieg	25		
Sum Lower Rhine and tributaries			**77**		**18,05**
D-RP	Ahr	Ahr (70 km), lower course	46		4
		Ahr (70 km), lower course	2		
		Ahr, upstream	3	x	
	Nette	Nette, downstream region (6.6 km)	3		0,17
		Nette, upstream	9		0,75
		Nette, upstream section (50 km)	14		
	Saynbach	Saynbach-Brexbach	12	x	1
	Moselle	Moselle, Koblenz (fish passage and visitors' centre in service)	1		5,18
		Moselle, downstream (Koblenz to Enkirch)*****	6		20
		Moselle, upstream (Zeltingen to Trier)	4		
		Elzbach, downstream	1		0,07
		Elzbach, upstream	12		
Lux		Sûre / Rosport	1		1,22
		Sauer, Erpeldange	1		0,11
		Sauer, Bourscheid	1		0,2
		Sauer, Dirbach	1		0,3
D-RP	Lahn	Lahn, lower section (Lahnstein until border RP/HE)	4		3,1
		Mühlbach, downstream region (6 km)	4		0,3
			2		
		Aar, downstream region (13 km)	10		0,9
D-HE		Lahn, border RP/HE until downstream the mouth of R. Dill	5	x	2,1
			1		
			2		
		Lahn, upstream mouth of R. Dill until border HE/NW	9	x	57,1
			3		
			19		
			26	x	
		Elbbach (downstream, 10 km to Hadamar)	6		1,1
		Elbbach, upstream to mouth of R. Lasterbach	9	x	1,5
		Dill (as far as Dillenburg-Niederscheld)	11	x	2,33
		Dill	5	x	2
		Dill	14	x	4,9
		Weil in the district Limburg-Weilburg until Utenhof	5		0,81
		Weil	2		0,24
		Weil	1	x	0,85
		Weil	1	x	3,3
D-RP	Nahe	Nahe, downstream, 5 km undisrupted	8		
		Nahe, upstream (105 km)	14		
		Nahe, remaining obstacles	11		5,1
D-HE	Wisper	Wisper, downstream and middle section	1		0,19
			1	x	0,3
Sum Middle Rhine and tributaries including Moselle			**291**		**119,12**

Annex 7: Master Plan Migratory Fish Rhine - hydro-morphological measures implemented and planned

Country	Section of the Rhine / tributary system	Waters/section, construction/s	Improvement upstream migration fish passage: Number of transverse structures	Improvement of habitat quality (=x) and further measures	Expenses (million Euros)*
DE-HE	Main & tributaries	Main: Kostheim	1		0,97
		Main: Kostheim (improvement fish passage, second entrance)	1		0,3
		Main: Kostheim downstream migration	1		4,00
		Main: Structural improvement measures (Flörsheim)		x	2
		Main: Eddersheim	1		2,6
		Main: Griesheim, Offenbach, Mühlheim, Krotzenburg	4		23
		Schwarzbach (Taunus / Main) near Hattersheim, remove lining	0	x	0,032
		Schwarzbach near Hattersheim, enhancement restriction	4	x	0,103
		Schwarzbach near Hattersheim, removal of consolidation	0	x	0,1
		Schwarzbach near Hattersheim, enhancement restriction	0	x	0,035
		Schwarzbach near Hattersheim, removal of consolidation	0	x	0,245
		Schwarzbach near Hattersheim (Bonnemühle)	1		0,008
		Schwarzbach near Hattersheim (outdoor pool)	1		0,081
		Schwarzbach / Eppstein - green belt	0	x	0,198
		Schwarzbach / Eppstein Rühl	1		0,1
		Schwarzbach / Eppstein Rühl II/Nottarp	1		0,1
		Schwarzbach / Eppstein Rühl cascade drop	1		0,04
		Schwarzbach / Hofheim (Obermühle)	1		0,14
		Schwarzbach / Eppstein, enhancement location of restriction	0	x	0,036
		Schwarzbach / Eppstein, enhancement location of restriction	0	x	0,035
		Schwarzbach / Eppstein, green belt	0	x	0,07
		Schwarzbach / Eppstein, green belt structure	0	x	0
		Schwarzbach / Lorsbach (Fabricasa)	1		0,06
		Schwarzbach / Eppstein (Schwarzmühle)	1		0,001
		Schwarzbach / Eppstein, enhancement location of restriction	1	x	0,576
		Schwarzbach / Eppstein (Wiesenmühle)	1		0,13
		Nidda (with Usa and Nidder)	16	x	3
			13	x	16,2
			35	x	10
		Kinzig (with Bracht, Salz, Bieber and Schwarzbach/Kinzig (= upstream Kinzig)	18		1,9
			5		1,1
			4	x	0,9
			32	x	3,6
D-BY		Main: from Aschaffenburg upstream to Gemünden***	11		
D-BW		Tauber	n. s.		
D-BY		Kahl, Aschaff, Elsava, Mömling, Gersprenz, Lohr, Mud, Erf****	n. s.	x	
		Sinn (and Kleine Sinn) and Fränkische Saale (with Schondra and Thulba)****	n. s.	x	
DE-BW	Weschnitz	Weschnitz	2	x	0,77
			5	x	2,13
DE-HE		Weschnitz	6	x	35,7
D-BW	Neckar**	Neckar: lowermost transverse structure near Ladenburg	1		0,49
		Neckar: Kochendorff, Lauffen (planning permission procedure; beginning of consgtruction work presumably by 2021)	2		5,4
		Neckar: Wieblingen/Heidelberg, Horkheim/Heilbronn and Gundelsheim (fish passages planned)	3	x	
D-HE		Neckar: Hessian section in the lower reaches	2	x	4,7
D-BW		Neckar: remaining sections (impoundments listed in the action and prioity concept to achieve the continuity of the federal waterway Neckar)	19	x	
D-RP	(Wies) Lauter	(Wies)Lauter Bienwaldmühle	1		0,25
		(Wies)Lauter, weir Scheibenhardt	1		0,38
F		(Wies)Lauter, Lauterbourg mill	1		0,16
D-RP		(Wies)Lauter, Berizzi mill	1		0,17
		(Wies)Lauter downstream	2		
F		(Wies)Lauter, French section near Wissembourg	3	Inventory	n. s.
		(Wies)Lauter, upstream section upstream of Wissembourg	1		0,42
D-BW	Alb/Moosalb	Alb downstream	3	x	2,45
				x	1,80
			2	x	0,38
		Alb upstream to mouth of R. Maisenbach in Marxzell	4		0,62
			1		0,03
			15	x	1,40
		Moosalb	1		0,15
	Murg/Oos system	Murg, downstream region (20 km)	1	x	9,50
			1		0,15
		Murg, upstream region until the mouth of the R. Forbach at Baiersbronn	7		1,20
			8		0,36
			13	x	6,23
		Reichenbach	1		0,15
		Oos system	4	x	5,31
			1		0,15
			3	x	2,56
F / D-BW	Rhine	Northern Upper Rhine: downstream of Iffezheim		x	1,80
				x	13,65
		Southern Upper Rhine: upstream of Iffezheim, Gambsheim	2	Telemetric study	20
		Strasbourg power plant	1		15
		Agricultural weir in the Gerstheim loop of the Rhine to connect the Rhine with the alluvial waters of the water body OR2 (Rhin 2) (target date according to conference of Rhine ministers Bonn	1		
		Gerstheim power plant: Construction of the fish passage	1		15
		2 agricultural weirs in the Rhinau loop of the Rhine open the access to the Elz-Dreisam-system and to connect the Rhine with the alluvial waters of the water body OR2 (Rhin 2) (target date according to conference of Rhine ministers Bonn 2007)	2		
		Rhinau power plant	1		
		Marckolsheim power plant	1		
		Hydro power plant at the agricultural weir Breisach (adaptation measures so that the fish passage is found well enough)	1		
		Vogelgrün power plant	1	Research	
		Old Rhine: Interreg project "Feasibility study concerning the revitalisation of the Old Bed of the		Feasibility study	
		Old Rhine: Renewal of the concession Kembs: Restoration of controlled erosion		Alluvial habitats	
		Kembs (renewal of concession): Construction of a new fish passage	1	Compensatory measures	8
D-BW	Rench	Rench (river continuity for salmon along 25 km)	15	x	7,5
			2	x	
			11	x	
F	Ill	Ill to mouth of R. Doller	1	x	
			1		
			27	x	
		Bruche, Giessen, Liepvrette, Fecht, Weiss, Doller	7	x	
			4		
			99		
D-BW	Kinzig	Kinzig (Baden-Württemberg)	36	x	39,5
		(continuity for salmon)	15	x	
		Tributaries Schiltach, Gutach, Wolfach, Nordrach, Erlenbach	17	x	
	Elz-Dreisam system	Old Elz & continuous branch of the old Rhine	8		25,0
			1		
			6		
		Leopodskanal	3		
		(continuity for salmon)			
		Elz upstream of Leopoldskanal	14	x	
		(river continuity for salmon up to river-km 85)	8	x	
		Tributary: Wilde Gutach	24		
		Dreisam	13	x	
		(river continuity for salmon up to river-km 21)	1		
		Tributaries: Wagensteig, Brugga, Osterbach	16	x	
Sum Upper Rhine & tributaries including Main			**612**		**300,12**

Annex 7: Master Plan Migratory Fish Rhine - hydro-morphological measures implemented and planned

Country	Section of the Rhine / tributary system	Waters/section, construction/s	Improvement upstream migration fish passage: Number of transverse structures	Improvement of habitat quality (=x) and further measures	Expenses (million Euros)*
CH/DE-BW	High Rhine	Birsfelden power plant	1		
		Augst-Wyhlen power plant	1	x	
		Rheinfelden power plant: Compensatory measures within new concession:	1	x	
		Ryburg-Schwörstadt power plant: bypass river for salmon, improvement of fishladder	1		
		Säckingen power plant	1	x	
		Laufenburg power plant	1	x	
		Albbruck-Dogern power plant: Nature-near bypass river with "collection gallery"; new fishway at the power house	1		
		Reckingen power plant	1	x	
		Eglisau power plant: within the new concession 2 fishways at the weir and the lock	1	x	
		Mouth R. Glatt: Construction of fishways in the Glattstollen as compensatory measure within the new concession for the Eglisau power plant	2		
		Rheinau power plant: Improvement of fish ladders at the auxiliary weirs or dismantling; increase of residual flow	3	x	
CH	Wiese	Wiese, downstream: Elaboration of pre-project for fish ladder at "Schliesse" (km 3.5) and	1		
DE-BW		Wiese, middle section and upstream	15	Structural improvement	9,00
		Tributaries: Kleine Wiese, Steinenbach; Kohlgartenwiese	18	Structural improvement	
			11	Structural improvement	
CH	Birs	Birs: downstream section: improved fish migration and revitalisation; replacement of 5 drop structures by block ramps (number: 1 + x)	7	x	
		Birs, upstream: improved fish migration (number: 1 + x)	2		
	Ergolz	Ergolz	1+n/s		
	Biber	Removal of several obstacles to river continuity and restoration of fish passability (2 + 4)	6	Connection	
Sum High Rhine & tributaries			**74**		**9,00**
D-BW	Tributaries to Lake Constance	Old Rhine, Höchst to outlet into Lake Constance	2	x	
		Bregenzerach: improve fish passage and ramps	4	Feasibility study	
		Upper and Lower Argen, lowermost hydropower plants	2		
		Upper and Lower Argen, upstream hydropower plant	n. s.		
		Schussen, gauging station Lochbrücke / Gerbertshaus	1		
		Schussen, hydropower plant Berg (accessibility Wolfegger Ach and Ettishofer Ach)	1		
		Seefelder Aach, hydropower plant Mühlhofen, improve river continuity	1		
		Stockacher Aach	21	x	1,3
		(river continuity for lake trout up to river-km 14)	2		
		Tributary: Mahlspürer Aach	3		
D-BY/AT		Leiblach and Rickenbach: Reconstruction of at least 3 transverse structures	3		1,5
D-BY		Oberreitnauer Ach (reconstruction transverse structures)	1		0,14
			2	x	
CH	Alpine Rhine	Fish passage power plant Reichenau	1		
		Lake Constance to mouth of R. Ill		Development concept	
AT/FL/CH		Confluence Posterior Rhine		Development concept, international flood protection / revitalisation project (RHESI)	
AT		Spirsbach	1	x	0,5
FL		Liechtenstein inland canal	1	x	
AT	Ill	Hochwuhr river km 8.0, fishway power plant with video surveillance since October 2010	1		
		weir Dabalada, km 20,0	1		1
Sum Lake Constance, Alpine Rhine & tributaries (Lake Constance sea trout)			**48**		**4,44**
Entire Rhine catchment			**1125**		**627,33**

** The R. Neckar and its tributaries are neither central migration routes nor habitats for anadromous fish species. When planning and implementing measures, long distance anadromous migratory fish species such as allice shad and the eel as a catadromous migratory fish species will be taken in to account.

*** In the Master Plan Migratory Fish Rhine of 2009, this river section is not indicated as programme water. If measures are planned or taken to restore river continuity, their definition will also take into consideration the diadromous fish species concerned. When updating the Master Plan it will be examined whether the river section will be included in the programme waters.

**** In the Master Plan Migratory Fish Rhine of 2009, these rivers are not indicated as programme waters. However, measures aimed at restoring river continuity and at improving habitats will take into account the requirements of diadromous fish species.

*****For the fish passage Lehmen the beginning of work is planned for 2018.

Annex 8: Non-governmental organisations with observer status in the ICPR

AK Wasser im BBU
Walter-Gropius-Straße 22
D - 79100 Freiburg
www.akwasser.de

Alsace Nature
8, rue Adèle Riton
F - 67000 Strasbourg
www.alsacenature.org

Arbeitsgemeinschaft Revitalisierung Alpenrhein/Bodensee
c/o WWF Regiobüro
St. Gallen
Merkurstr. 2
CH - 9001 St. Gallen
www.lebendigerrhein.org

Arbeitsgemeinschaft der Internationalen Wasserwerke im Rheineinzugsgebiet IAWR
Parkgürtel 24
D 50823 Koblenz
www.iawr.org

Arbeitsgemeinschaft Renaturierung des Hochrheins
Weinsteig 192, Postfach 1157
CH – 8201 Schaffhausen
www.arge-hochrhein.ch

Bund für Umwelt und Naturschutz Deutschland
Landesgeschäftsstelle Rheinland-Pfalz
Hindenburgplatz 3
D - 55118 Mainz
www.bund-rlp.de

Conseil Européen de l'Industrie Chimique (CEFIC)
Avenue E. Van Nieuwenhuyse 4
B - 1160 Bruxelles
www.cefic.be

DWA Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e.V.
Theodor-Heuss-Allee 17
D - 53773 Hennef
www.dwa.de

EBU - UENF
Postbus 23210
NL - 3001 KE Rotterdam
www.ebu-uenf.org

EurAqua Network
Deltares
Princetonlaan
P.O.Box 85467
NL - 3508 AL Utrecht

www.euraqua.org

European Union of National Associations of Water Suppliers and Waste Water Services
EUREAU
Rue Colonel Bourg 127
B - 1140 Bruxelles
www.eureau.org

Greenpeace International
Keizersgracht 176
NL - 1016 DW Amsterdam
www.greenpeace.org/international

Hochwassernotgemeinschaft Rhein Gemeinde- und Städtebund
Deutschhausplatz 1
D - 55116 Mainz
hochwassernotgemeinschaft-rhein.de

NABU-Naturschutzstation NABU-Koordinationsstelle Rhein
Bahnhofstraße 15
D - 47559 Kranenburg
www.nabu.de und www.nabu-naturschutzstation.de/v1

Rheinkolleg
Steubenstraße 20
D - 68163 Mannheim
www.rheinkolleg.de

Verband Deutscher Sportfischer e.V.
VDSF Siemensstr. 11-13
D - 63071 Offenbach
www.vdsf.de

VGB Power Tech e.V.
Klinkestraße 27-31
D - 45136 Essen
www.vgb.org

Wereld Natuur Fonds
Driebergseweg 10
Postbus 7
NL - 3700 AA Zeist
www.wnf.nl

WWF Schweiz
Hohlstraße 110
Postfach
CH - 8010 Zürich
www.wwf.ch

Annex 9: List of competent authorities for river management in the IRBD Rhine according to WFD; Article 3, Par. 8 (Annex I)

State	Switzerland	Italy	Liechtenstein	Austria	Germany	Germany	Germany	Germany	Germany	Germany	Germany	Germany	France	Luxembourg	Belgium	Netherlands
Country		Lombardy region		Vorarlberg	Bade-Wurttemberg	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 WFD (CH) Authority in charge of information / coordination: Bundesamt für Umwelt BAFU	Region of Lombardy, for great construction projects such as dams the national 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 infrastructure - environmental departments	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	BAFU 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	Rosenkavalierplatz 2 D-81925 München	Mainzer Str. 80 D-65189 Wiesbaden	Kaiser-Friedrich-Str. 1 D-55116 Mainz	Keplerstr. 18 D-66117 Saarbrücken	Schwannstr. 3 D-40476 Düsseldorf	Archivstr. 2 D-30169 Hannover	Beethovenstraße 3, D-99096 Erfurt	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 Nederland
Legal status of the authority in charge	National regulatory body	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 coordinating 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, coordination	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 State Authority for Environment and Geology)	39 (2 structural and approval authorities, 36 subordinate water agencies, federal authority for environment, water management and trade control)	9 (8 Lower Water Authorities, 1 Federal 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)	Results of reorganisation are expected.	1 Administration de la Gestion de l'eau	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)	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.