



# The Rhine A RIVER AND ITS RELATIONS



Internationale  
Kommission zum  
Schutz des Rheins

Commission  
Internationale  
pour la Protection  
du Rhin

Internationale  
Commissie ter  
Bescherming  
van de Rijn



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Heinrich Heine (1844):  
*Welcome, oh Father Rhine,  
How have you been doing?  
Often have I thought of you,  
Impatiently and full of nostalgia.*

**How is "Father Rhine" doing? His waters have become much cleaner, more and more salmon migrate from the sea and into the Upper Rhine.**

**At the time being, the migration route is interrupted in Strasbourg. However, enormous fish passages have been constructed at the dams of Iffezheim and Gamsheim, opening the way into the tributaries from the Black Forest and Alsace. And what is more? - May we lean back and rest on the laurels of a European model river remediation?**

The Rhine has already answered this question. In spite of successful action programmes, the canalized river again and again utters its discontent with great floods. A climate change might aggravate such catastrophes. Extreme flooding would endanger millions of people and assets worth billions in the Rhine floodplains. Therefore, the International Commission for the Protection of the Rhine (ICPR) drafted an **Action Plan on Floods** and developed an integrated programme, **Rhine 2020**, for the Rhine and its floodplains.

The economic performance of people along the Rhine during the last two thousand years has been considerable. However, ignoring their chains of manifestation, man interfered with complex natural cycles. Age-old relations were torn and the Rhine ecosystem lost its balance. There must be a way to use the Rhine in line with nature and socio-economic requirements. At the outcome of the 1992 Rio de Janeiro meeting, the states of the world agreed on **sustainable development** and on conserving **biological diversity**. Transboundary **river management** as the ICPR practises for the Rhine and as the European Union pursues for the whole of Europe may implement sustainable water policy.



## 1. Pure Rhine gold? How we use the river

**There are different reasons for why the Rhine developed into an economic axis in Europe. The decisive factors were above all the waterway and the Rhine as a source of water as raw material. Since the Middle Ages, the diversity of the city cultures on its banks also had its part. From Basel to Rotterdam, industrial centres developed as pearls on a lace. Today, the Rhine is the most heavily used river with the greatest diversity of use throughout Europe. It flows through six states, nine nations have a share of its watershed.**

Victor Hugo (1839):  
*... I love rivers, carrying ideas as well as goods. ... of all rivers I most love the Rhine.*



From the second half of the 19th century, the development of the Rhine into a waterway and the construction of harbours, railroads and roads turned the Rhine valley into the traffic axis it is today. Two main industries rose from the formerly great commercial diversity, with textile industry in a leading position: heavy industry and chemical industry. The

latter often developed from dye-works supplying the textile industry. For the chemical industry, the Rhine developed to be an important site factor, as it served transportation of raw materials and goods, it was a source of cooling and process water and was used for disposing of wastewater.

In the 20th century, the Rhine additionally developed into a centre of energy: electrical networks as well as numerous coal, nuclear and water power stations were built, along with refineries and petroleum and natural gas pipelines.



## Old relations with the Rhine

But the history of civilization along the river is much older. 2000 years ago, people along the Rhine cherished the river as river god "Rhenus". During the first wars along the Rhine, men fought tough battles and Cesar reported of women's prophecies from "whirls, meanders and roars" of the river.

People believed in the divine forces of the river at least up to the Middle Ages.

**Francesco Petrarca (1333)** about the Rhine near Cologne:  
*The banks were entirely covered by a huge, gleaming crowd of women... In the gay medley they washed their white hands and arms in the torrential stream ...it was said to be an age-old custom ... and possibly threatening disaster for the entire year to come is being rinsed away by the washing in the river this very day.*



Roman river god Rhenus

**Ancient names:**  
 Celtic: Renos  
 (= flowing water, river, sea)  
 Latin: Rhenus

As the Rhine landscape changed more and more with the beginning of the Industrial Age, poets and painters of the Romantic Age recalled the natural beauty of its valley, they were the first tourists to travel through it and sometimes they regretted the loss of nature.

Maps of the Upper Rhine near Mannheim show the subsequent rapid increase in population and urban settlements.

Until 200 years ago and as long as the Rhine was a torrential stream, its natural riches fed primeval trades: salmon fishermen, bird catchers and gold washers.

**Robert Lauterborn (1938)** about the Upper Rhine until the beginning of the 19th century: *Boatmen and raftsmen, silently gliding downstream, some salmon fishermen on the banks in their reed huts wrapped up in nets, gold-washers and fowlers on the gravel banks, the gold-washers tirelessly pouring one shovel of gravel or sand after the other onto the wash bank, the fowler silently and patiently trying to bait the by-passing flocks of Nordic ducks into their nets. All these figures and professions which have remained the same since ancestral days.*





**Heinrich Böll (1977):**

*I spent the major part of my childhood and youth along the Rhine. Just sitting on its banks, watching the ships and, let us say that the cosmopolitan aspect of this act probably deeply impressed and marked me.*

## Nothing stops navigation

The first boatsmen on the Rhine were Ice Age hunters travelling on the Rhine in dug-outs some 12,000 years ago. With their rowing boats and the first cargo vessels, Celts and Romans later turned the Rhine into a trade way. Rafting of timber also began in Roman times. From the Middle Ages on, traders used vessels to sail or to tow which, after 1820, were replaced by steam vessels. After 1900, motor boats capable of transporting several thousands of tons replaced the steam vessels. Today, multiple barge convoy sets transport several thousand tons of goods.



Towing on the Rhine around 1600

**Victor Hugo (1839),**

Andernach:

*On the other bank of the Rhine, at the foot of a high and dull hillside, thirteen horses slowly towed another ship upstream. Its huge triangular sails were filled by the evening winds, helping the horses with their tasks. The measured steps of the teams, the sound of their bells and the cracking of whips came across to me.*

The regulation of the Upper Rhine by the engineer Tulla began in 1817



**Erich Kästner (1932) on the Loreley:**

*We are changing. So are the vessels. The Rhine is regulated and dammed. Time goes by. You no longer die while shipping just because a fair woman continually combs her hair.*

The Middle Rhine at the Loreley rock

The free passage of the vessels was more and more often impeded by the "multitude of dynasties", as the French historian Lucien Febvre called it. "In 1789, there were 97 'sovereign' states on the banks of the Rhine between the rivers Lauter and Ijssel." The 1814 Paris Peace Treaty and the 1886 Mannheim Act of the Rhine bordering countries granted free traffic for vessels on the Rhine.

When water workers forced the torrential stream into a stable bed and fixed its course to gain land, they more or less improved navigation as a by-product. It was not until the Rhine was developed into a major waterway, e.g. by improving the dangerous narrow stretch along the Loreley – that the Rhine became one of the worldwide most trafficked waterways with Duisburg as the largest inland port and Rotterdam as one of the largest sea ports. The vessels transport raw materials and goods, dangerous chemical substances and tourists. Annually, some 200,000 vessels cross the German-Dutch border transporting about 200 million tons of goods, above all construction material, petrochemical products, ore, charcoal and containers.





## Silver salmon were the gold of the Rhine

Until the end of the 18th century, the Rhine, abounding in fish, was an important source of food. It was said to be Europe's best salmon river and, until the end of the 19th century, fishery was considered to be a gold mine.



Fisherman with salmon on the Lower Rhine near Xanten 1934

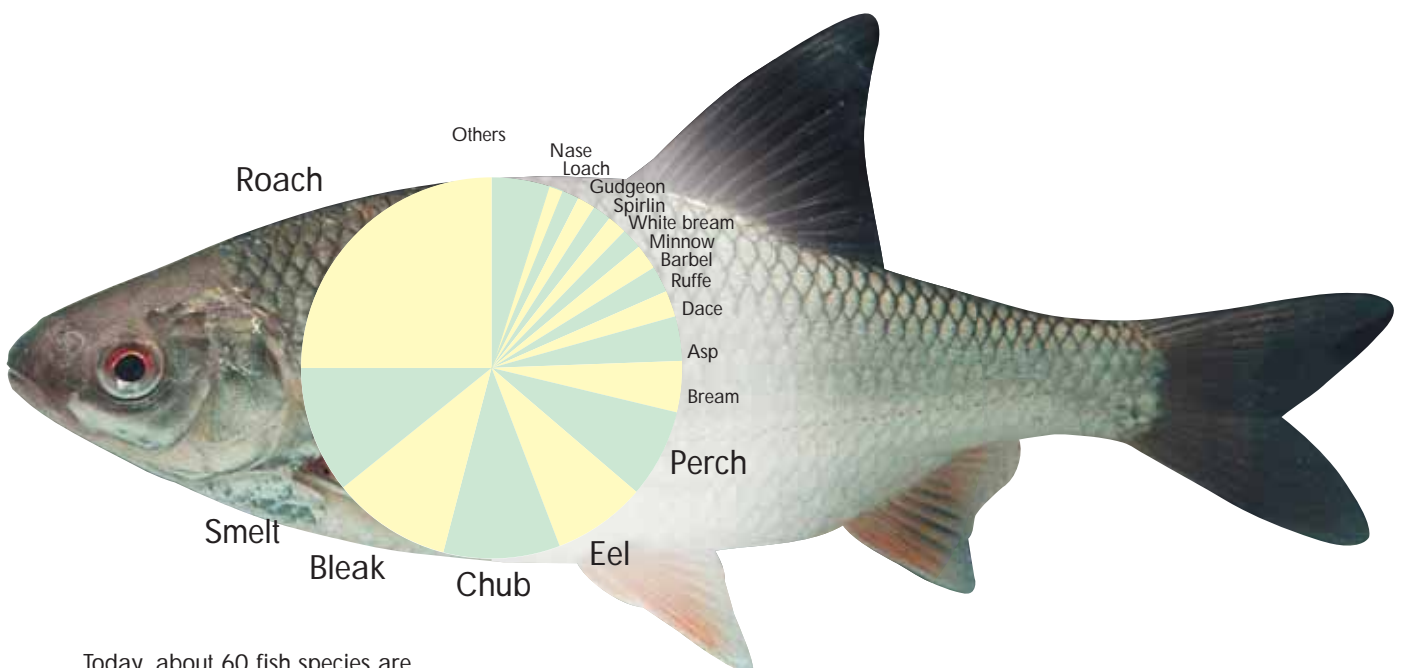


Victor Hugo (1839)  
near St. Goar:

*From time to time, halfways hidden below brambles and willow bushes and almost lying in ambush, a sort of gigantic spider appears... This spider is a jumping net. Some time later, the mysterious lifting stick limps up, in this silent loneliness, the loathsome animal rises, holding a net between its four legs, in the middle of which a beautiful silver salmon twists and jumps.*

Formerly, there were hundreds of professional fishermen between the Alp Rhine to the Lower Rhine. Today, there are only a few of them. However, leisure angling has distinctly increased. Several hundred thousand anglers are today fishing in the Rhine.

In the 1920s, Dutch salmon fishermen complained about the bad taste of the fish due to the discharge of wastewater from the Ruhr area containing phenol. Today, Rhine fish hardly present any residue contamination.



Today, about 60 fish species are living in the Rhine. Due to the monotonous structure of the Rhine, most of them are undemanding ubiquists.

## Pure Rhine water is worth gold

People living on the banks of the Rhine did probably not use to drink water directly from the Rhine. Even the clean Rhine carried along too much suspended matter. 30 million of the 58 million people who today live in the Rhine watershed **drink** treated Rhine water which, in most cases, is produced from riverbank filtrate. As a matter of precaution, the water works pass the water through activated carbon filters. Still, water is more closely examined than most other beverages.

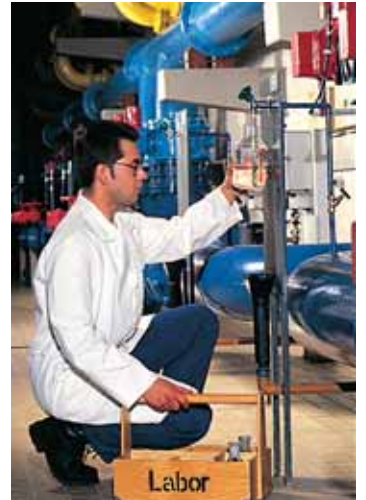
Since the Middle Ages, hygienic conditions must have stunk high to heaven in the towns on the Rhine. Up to the 19th century, there was no sewerage, so that, at that time, almost no effluents were directly discharged into the Rhine. Floods, however, had to swallow a lot.

It was not until the second half of the 19th century that the Rhine began to serve as washing machine and sewage channel. In 1901, the development of the Rhine into a "sewer" was an issue of discussion in the German Reichstag. Upon this discussion, the Reichsgesundheitsrat gave order to canvas the Rhine and found a red sewage plume between Ludwigshafen "as far as Worms". The city of Frankenthal discharged "dirty waters carrying a medley of floating rests of dirt", the Mannheim paper pulp industry added "yellowish waters".

### Wolfgang Koeppen (1953):

*On the roads along the Rhine,  
black Mercedes roar down-  
stream along the waters.  
Downstream the sludge, down-  
stream the driftwood, down-  
stream the bacteria and excre-  
ments and the lyes of industry.*

**Victor Hugo (1839)**  
about Wellmich on  
the Middle Rhine:  
*On the banks of the  
Rhine, young laun-  
dresses are chatting,  
gaily beating their  
linen in the sun.*



Water works



### Samuel Taylor Coleridge (1798):

*The River Rhine, it is well known,  
Doth wash your City of Cologne;  
But tell me Nymphs? What power divine  
Shall hence forth wash the River Rhine?*





Landfill "de Slufter" in Rotterdam

Under the title "*Just dump it into the Rhine*" even the German Home Office stated in 1976, at the peak of Rhine pollution: "*The age of the salmon belongs to the past. Instead, the sewage fungus Sphaerotilus is abundantly thriving.*"

Since then, Rhine water quality has considerably improved. Formerly, the city of Rotterdam annually had to dredge 10 million m<sup>3</sup> of contaminated sludge out of the Rotterdam harbour basin to be tipped into the 90 million euro hazardous waste landfill "de Slufter". Today, "only" 1 million are annually tipped.

Today, more than 96 % of the wastewater generated by industry, trade and households in the Rhine are cleaned in wastewater treatment plants. Diffuse, that is non point inputs of pollutants, in particular fertilizers and pesticides from applications in agriculture are problematic for water quality. Precautionary action and close surveillance by administrations in the Rhine watershed continue to be indispensable. But the contamination of the Rhine with heavy metals and many pollutants has decreased, oxygen content and species number of benthic invertebrates in the river bed have risen. Many euryoecious "new species", such as mussels, snails and copepods arriving with vessels from the Black Sea, North America and Asia are found among the benthic invertebrates in the river bed.

From 1990 to 1995, the basket clam *Corbicula fluminea*, originally native in East Asia, came upstream the Rhine from the estuary to Basel and is, in certain places, the most frequent mussel species in the Rhine.



## The tamed river – a source of energy

**Alfons Paquet (1923):**  
*... thus a collective and Faustian fantasy is planning the engineerlike development of the river, being unchained and tamed at the same time. (...)*  
*The hydraulic power of the Upper Rhine corresponds to the intensity of combustion slumbering in the inexhaustible stocks of a gigantic charcoal mine.*



The Laufenburg power plant today

The Laufen-Falls at Laufenburg with "salmon scales" on the banks



As early as the Middle Ages, many water mills in the Rhine area exploited hydraulic power. They transformed hydropower to mechanical power in order to grind cereals and silica, to saw wood or to grind ore.

Towards the end of the 19<sup>th</sup> century, the Swiss and Germans started to turn the High Rhine into a succession of lakes in order to gain electric power with the help of recently invented turbines. The barrage weirs of 11 hydro-electric power plants drowned waterfalls and cataracts. Thus, in 1914, the well-known Laufen (rapids) of Laufenburg vanished.

Today, only 4 stretches with free flow are left on the High Rhine: upstream the Falls of the Rhine and at the confluence of the rivers Thur and Aare.

The hydroelectric power plants on the High Rhine barred salmon migration into the traditional spawning areas in the Aare and other tributaries.

The development with a view to exploiting hydroelectric power on the Upper Rhine started in 1928. Four hydroelectric power stations were built in a canal parallel to the Rhine and almost dried up the old bed of the Rhine which we today call "Old Rhine" or "Restrhein". In the following section up to Strasbourg, four hydroelectric power plants were built with "canal loops". Downstream of this section, two further power stations were built in the canalised Rhine itself, 1974 in Gamsheim and 1977 in Iffezheim. These too represented insurmountable barriers for migratory fish such as salmon on their way upstream.



## Rich land on the banks

More than 50 % of the surface of the Rhine watershed are exploited by agriculture. Via groundwater and surface waters all these fields, meadows and vineyards drain into the Rhine.

Prior to river training, the nutrient-rich fine sediments of floods naturally fertilized the floodplains of the Rhine.



Before the river was trained, the Russian author Karamsin travelled through the Upper Rhine valley between Mainz and Mannheim and also experienced the threatening effects of floods in the fertile "rich plains". This "voice of the water", as the expressionist poet Hendrik Marsman called it, still particularly characterizes the Rhine delta area in the Netherlands.

Agriculture and viticulture are today most profitable and most intensive in the floodplains along the Upper and Lower Rhine, in the drained marshes of the Delta Rhine and on the steep slopes of the Moselle and the Middle Rhine.



### Hendrik Marsman (1899-1940):

*Denkend aan Holland  
zie ik brede rivieren  
traag door oneindig  
laagland gaan, (...)  
en in de geweldige  
ruimte verzonken  
de boerderijen (...)  
de lucht hangt er laag  
en de zon wordt er lang-  
zaam  
in grijze veelkleurige  
dampen gesmoord,  
en in alle gewesten  
wordt de stem van het  
water  
met zijn eeuwige rampen  
gevreesd en gehoord.*

*Thinking of Holland  
I see broad streams  
lazily flowing  
through wide lowlands,  
(...)  
And farms  
sunk deep  
into the enormous space  
(...)  
The skies hang low  
and the sun  
gradually wraps up  
in many coloured grey,  
everywhere  
the voice of the water,  
eternally portentous  
eternally feared.*

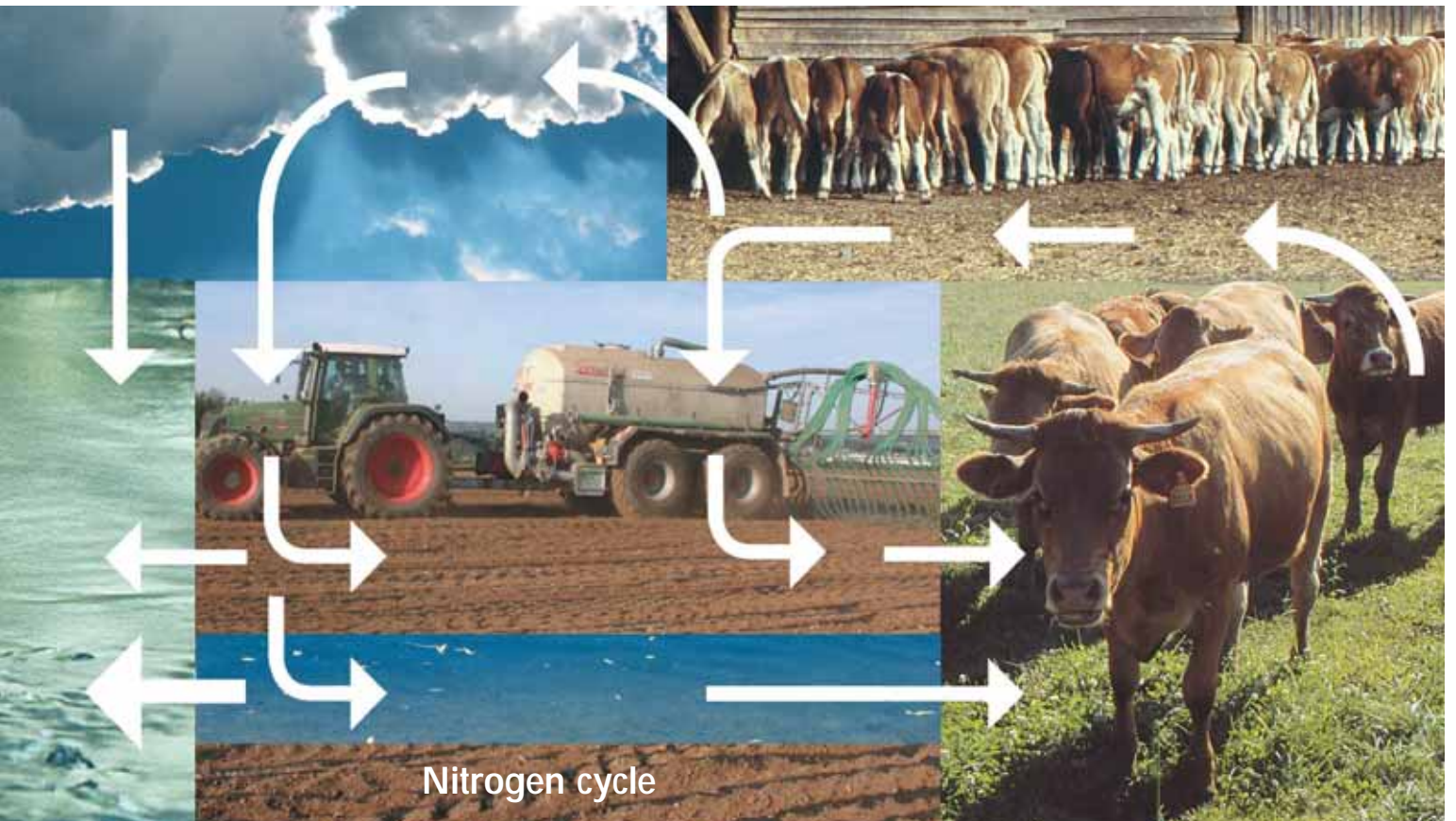
### Nikolaj Michailowitsch Karamsin (1766):

*Heavy rain had caused the rivers Rhine  
and Neckar to swell enormously, their  
devastating waves flooded gardens, fields  
and villages. Here, parts of a demolished  
house floated by, ... There a poor bleating  
sheep was carried away by the floods! - In  
some places, we had to drive through the  
waters which sometimes even penetrated  
into the car.*





Upper Rhine south of Iffezheim



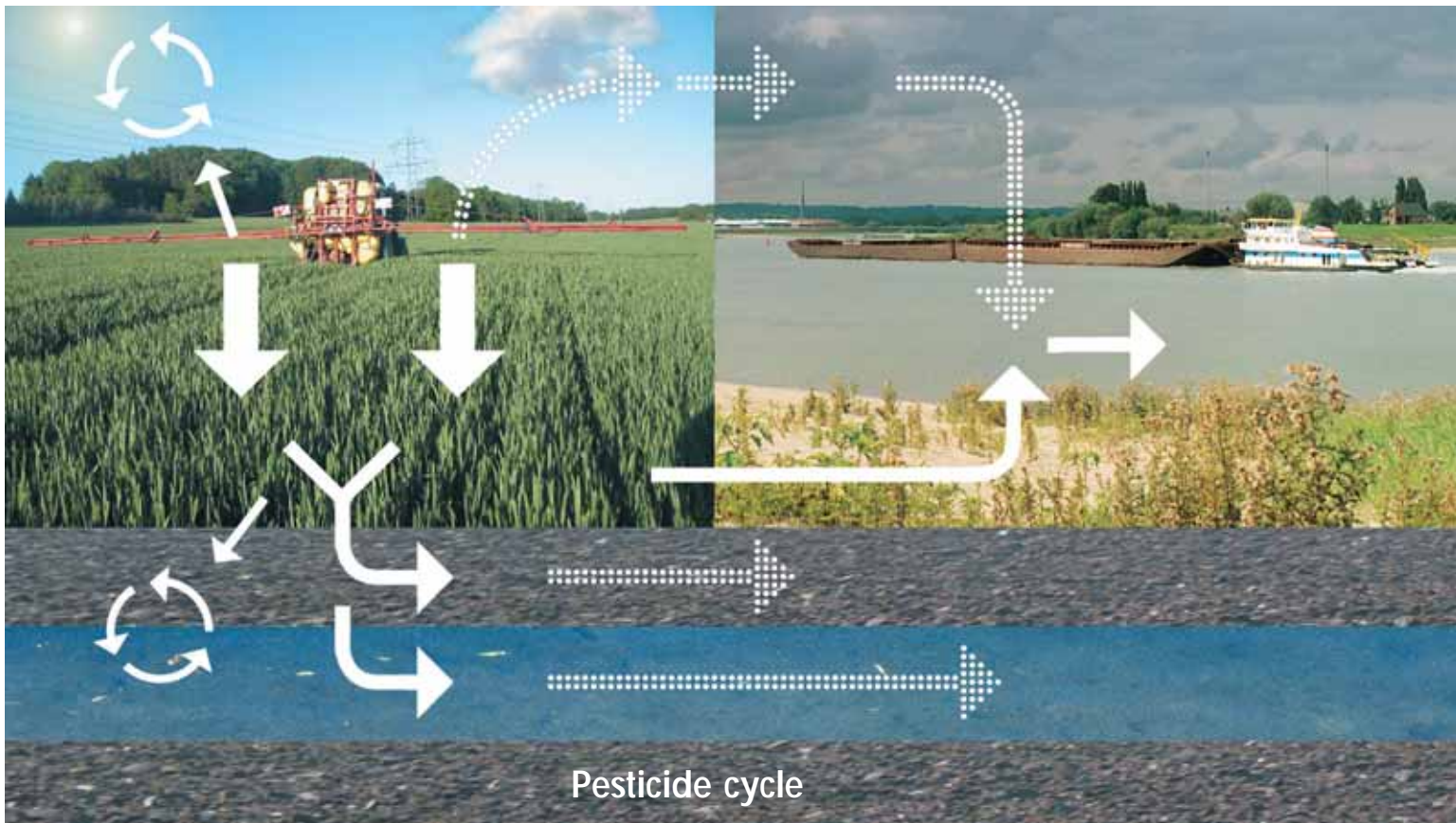
Nitrogen cycle





Fertilizers and pesticides from too intensive agriculture, erosion and uniform landscapes often interfere with water bodies and their biocoenosis.

In the same way, other uses may harm the Rhine and its floodplain. River training for navigation purposes cuts off backwaters which are then filled in by sedimentation or silt more rapidly. Dams turn rivers into a chain of lakes, impede fish migration and deepen the riverbed downstream of the weirs which makes the groundwater table of the valley sink in line with the river. Embankments and construction activities in the floodplain lead to higher flood waves and tear apart ecological networks between the Rhine and the surrounding land.







## 2. Pure nature? How ecology links

**Biologically, we may consider the Rhine as an ecosystem, as a network of relations between its habitats and organisms, its energy and material cycles which open towards the exterior and change in the course of time.**

**Man is part of the Rhine ecosystem and has taken great influence on it. On the other hand, the river influences us, as historians such as Lucien Febvre say: even though, at times, the Rhine separated people, its great special feature is to unite and to reconcile, to promote intellectual and material exchanges.**

**Berndt Heydemann (1997):**  
*Ecology is nothing but biological economy.*  
*... species join to ecosystems comparable to geographical core areas and integrated economy.*

A stream such as the Rhine shows the typical characteristics of an ecosystem, that is openness, dynamics and network development much more clearly than e.g. a lake. Nevertheless, it is only in the recent past that we have again begun to consider its landscape as a whole.

2 500 year ago, the Greek philosopher Heraklit is said to have said "*Pantha rei – everything flows*". The biochemist Erwin Chargaff recently wrote: "*Flowing while persevering is a sign of life*". But it is still a mystery, in what way the dynamic balance of energy, matter and information works in the ecosystem of our earth. The Dutch poet van den Vondel was probably among the first to describe the well-known **water cycle**.

**Ecosystem**  
 – originally Greek:  
 oikos =  
 house, belonging  
 systema =  
 aggregated whole

**Johannes Kühn (1989):**  
*Slight rainfall made us feel that the sea is still remembering us.*





**Joost van den Vondel (1667):**  
*Just like the network of veins  
streams through our body,  
water is flowing through thou-  
sands of veins of our earth. The  
beaming sun draws its steam  
from the oceans, concentrated  
in clouds it falls down as rain.*



Jan van Goyen (1652)

## "Groundwater – a hidden pillow"

Groundwater connects a river with its valley, since there is a constant exchange between both. At times of mean water flow, the groundwater flows underground with the river. During low water levels, the groundwater supplies the river and during floods water flows from the river into the groundwater.

Apart from that, the groundwater is recharged by precipitation penetrating into the soil, gathering over impermeable layers, such as clay and slowly flowing on. In places, where the groundwater table is close under the surface, as in the shoulder hollows of the Rhine flood-plains, a particular vegetation may grow in valley bogs and fenwoods.

Where groundwater seeps, a **spring** rises and a brook is born. There are marshy pool springs, cataract springs, seeping springs or bog springs. The temperature of the spring hardly varies, which is why it appears to be cold in summer and warm in winter. The filling of the springs naturally depends on precipitation, the water seepage in the soil, the movement of the groundwater and the groundwater table.

**Alfons Paquet (1923):**  
*... the mild firmness of the cur-  
rent and its hidden pillow, the  
groundwater, providing fields,  
villages and towns with wells.*





# "A splendidly designed water life"

The Rhine is not only made up of the main stream and the glacier sources in the Alps, but of thousands of sources in its **watershed** with hundreds of brooks, tributaries and lakes. In this network of water bodies, water is flowing in every direction, but always downstream towards the sea.

Alfons Paquet (1923):

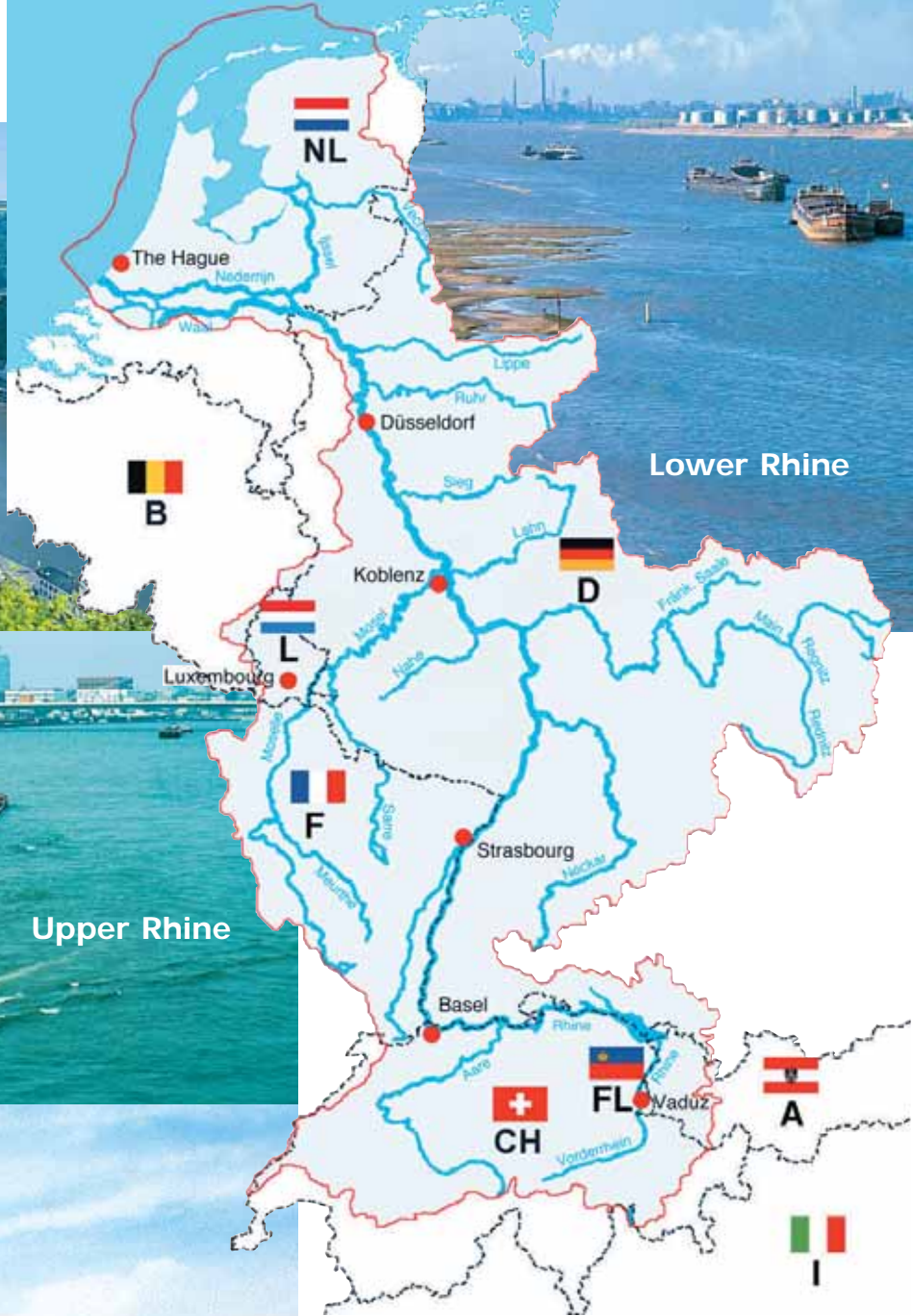
*On the map, the Rhine looks like a tree. Its sources are the roots, its tributaries are the branches of the stem, its many delta branches are the crown. It is an organism, indeed ... It is a system, a splendidly designed water life in the middle of the country ...*



Delta Rhine



Middle Rhine



Upper Rhine



High Rhine



Alp Rhine/Lake Constance

### Rhine watershed:

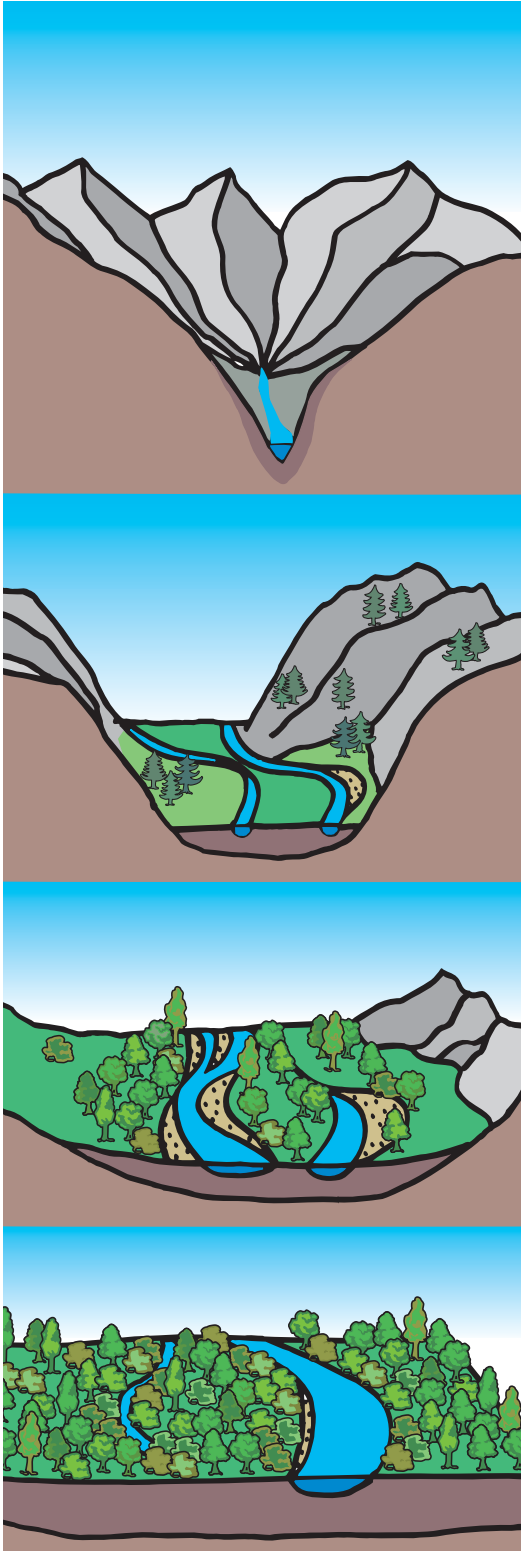
- Total surface: 197.000 km<sup>2</sup>
- Germany: ca. 100.000 km<sup>2</sup>
- Switzerland, France, Netherland: each 25-35.000 km<sup>2</sup>
- Italy, Austria, Liechtenstein, Luxemburg, Belgium: ca. 6.000 km<sup>2</sup>



In the course of the history of the earth, the Rhine has changed its appearance, it has grown like a tree. 5 million years ago, the primeval Rhine (Ur-Rhein) had its source at the Kaiserstuhl and flowed into the sea even before the present Dutch border. Later on, its watershed grew to comprise the River Aare and the Alp Rhine, which had earlier poured into the Rhône and the Danube.

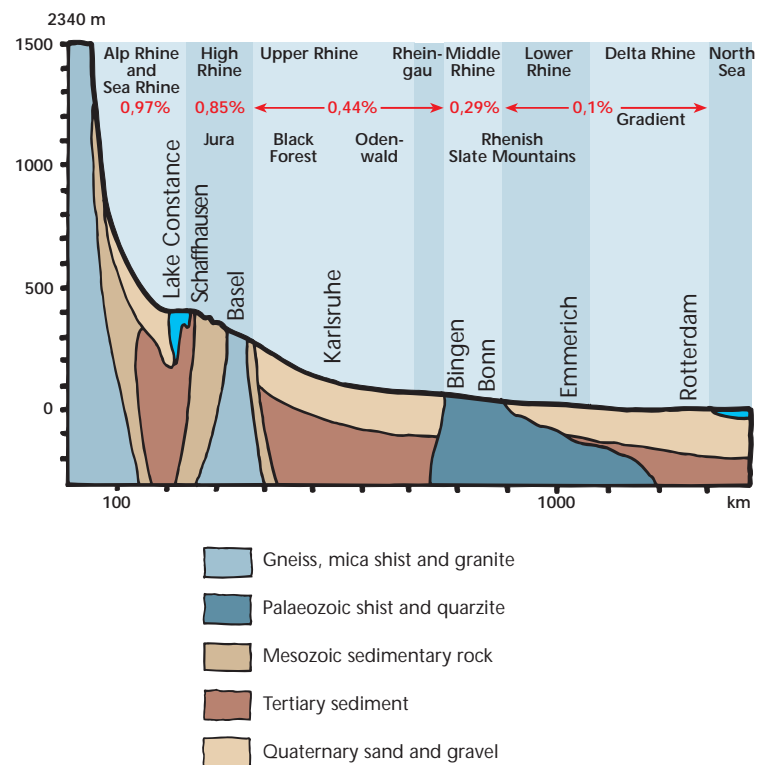


Until quite recently, the geological history of the Rhine was reflected by the **dispersal pattern of its fauna**. The correction of the Rhine and stocking with fish has however almost wiped out this memory of the river, as these measures made the main stream uniform. Formerly, there was an invisible frontier in the middle of the Upper Rhine, which split the spreading of certain species of snail, mussel and even fish species. The northern species belonged to the fauna of the primeval Rhine with the rivers Kinzig and Lower Neckar as its roots, the southern species belonged to the formerly separate Rhine system consisting of the rivers Ill, Aare and Alp Rhine.



Cross-sections of a natural river landscape

Longitudinal profile of the Rhine



## Habitat connectivity in running waters

The natural flowing water ecosystem may be considered as an unbroken continuity, a so-called *continuum* gradually changing with the gradient. Three sections are to be distinguished: the upper, the middle and the lower reaches with the index fish species trout, umber, barbel and bream. The "mincing species" living on leaves falling from the trees are typical benthic invertebrates living in the river bottom of the upper reaches. In the broader and more sunny middle reaches, the typical benthic invertebrates are "grazing species" living on algae growing on stones. Suspended algae, the so-called phytoplankton serving as food for minuscule crustaceans of the zooplankton thrive in slowly flowing waters and in backwaters. In the lower reaches, the bottom-dwelling fauna almost exclusively consists of "gatherers or filter-feeders" which only make up half of the fauna further upstream.

The larva of the Rhine-ephemera *Oligoneuriella rhenana* was formerly abundant in the Rhine, today it is only found in the tributaries.



**Ragnar Kinzelbach (1992):**  
*The losses and increases of species in the Rhine have changed its fauna more lastingly during the past 150 years than did the 10 000 years since the stabilization of the river system following the last Ice Age.*

In today's Rhine system, the ecological longitudinal segmentation is hardly recognizable. River training has crowded out specialized species which e.g. had high demands to the structure of the river bottom. Today, many species belonging to the group of stone flies are lacking. Within the Rhine Action Programme of the ICPR, more than 200 benthic invertebrates were found in the Rhine between Lake Constance and the North Sea.

The river biocoenoses have perfectly developed the strategy of rapid **recolonization** after natural disasters, such as floods or low water. Benthic invertebrates then return from the layer between the river bottom and the groundwater (*hyporheal layer*), where fish larvae, e.g. of salmon may even hide in sand-filled interstices up to 30 cm below the river bottom. Apart from that, life in rivers may be restored due to passive drifting downstream and to active movement upstream (fish, crustaceans) or above the water level (insects). On flood waves or flotsam, seeds and insects may travel to new banks. However, river training, dikes and dams heavily restrict migration.

Technical river regulation and dams interfere with or reduce:

- river dynamics
- river bank vegetation
- interconnection between the river and its floodplains
- migration of aquatic organisms
- natural species diversity





## "Intact floodplains are like the Wadden Sea"

The floodplain or the zone of water exchange in the river valley is influenced by floods. It is an area of contact between river and land. Exchanges take place, species spread. In the headwaters of brooks, this zone is by nature narrow, along the river it may cover kilometres.

Trees growing along the brook give shade, keep its temperature low, reduce

flooding and protect the banks against erosion. Leaves and insects falling into the water feed the benthic invertebrates. Together with the Wadden Sea, the rivers and their floodplains used to form the most productive ecosystems in Europe with greatest species diversity. Due to their high biological activity, riverside soils figure among the most fertile ones. Biocoenoses of floodplains and rivers are interconnected by a diversified network.

Floodplains and riparian zones of a river are exposed to a continuous change from humidity to aridity, sedimentation and erosion, nutrient inputs and leaching. Plant and animal communities have adapted to such dynamics; they not only tolerate them, but they even depend on them.



**Henri Décamps (1996):**

*Most of the processes involved in the structure and function of river ecosystems are controlled by floodplain forests.*

**Biological diversity according to the UN Convention of 1992:**

*... the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes the diversity within species, between species and of ecosystems.*  
(BBN 1999)





# Biological diversity



Herwig Klemp (1997):  
*Intact floodplains are like the Wadden Sea: Both are inconceivable without the continuous rise and fall of the water, but the variation of water level is much more irregular in the floodplains than that of ebb and tide.*



Little bittern



Euphorbia

British inula

Bluethroat



Due to their luxuriant growth, their complicated vertical stratification and their abundance in liana, **the last floodplain forests** of the Upper Rhine are comparable to tropical rain forests. The hardwood-floodplain forests containing more than 40 wood-like plant species belong to the most diversified and most highly developed plant communities in Europe.

After flood waves have destroyed the vegetation, the life cycle of the floodplains begins anew with the first tender pioneer plants emerging from the bare soil. The **softwood-floodplain vegetation** with white poplars and black poplars represent the next development stage on the raw soil along the river. Willow roots sprout from branches in the driftwood and form floodplain shrubberies. Due to their deep roots and their supple branches they resist to further floods. Black poplars spread due to their subterranean root-suckers. After 60 to 120 years, the softwood-floodplain vegetation may slowly develop into a forest of alders and ash trees before becoming a more stable **hardwood-floodplain vegetation** dominated by ash tree, elms and common oak, where wild apple and pear trees blossom and the lianas of clematis, hop, ivy and wild grapes rank around the trees and hang from their crowns like a veil. It takes another 150 years, before this forest has attained its definite maturity. Only at an age of 250 years has this forest reached the stage of a well-balanced mosaic comprising all development stages, including the ecologically important dead wood. The open crowns of the ash trees allow the dense underbrush consisting of bushes and herbs to develop.

This species and structural diversity of vegetation is the basis for the development of a multitude of insects and **birds**, e.g. six species of woodpeckers, golden oriole and nightingale joining in a marvellous spring concert in order to mark their territories. In the rich structure of the hardwood-floodplain vegetation, the most species-rich bird fauna of Europe is to be found in a maximum density of up to 200 couples on a surface of about 10 ha. Today, many of the floodplain bird species no longer breed along the Rhine. This is e.g. true of osprey and little crane, other species, like bluethroat and little bittern have become very rare.



Nightingale



Middle-spotted woodpecker



Water fringe



Tree frog



Water nut



Moor frog



Kingfisher



Pike

Otter



Natterjack

The **amphibians** are particularly well adapted to the habitats with varying humidity. When floods withdraw and only leave behind marshy pools on the naked soil, tree frog, natterjack and green toad gather around the puddles and invite their far-away partners with loud snarls or warbles to join them for mating. The puddles quickly heat in the sun and tadpoles rapidly develop. But their life is a race against death. New floods may carry away the spawn, hot-spells may dry out the puddles. Then a black, tar-like film of dead tadpoles covers the hollows. But some of them survive and leave the puddles as minuscule toads or frogs.

**Formerly, the floodplain forest covered** a surface of 2 000 km<sup>2</sup> along the Upper Rhine, it was up to 12 km wide and split up by many backwaters, pools, torrents and beaver meadows. Today, about 150 km<sup>2</sup> of riverside forest are left, 70 % of which consist of forest plantations. Less than 1,5 km<sup>2</sup> of sub-natural floodplain forests are older than 150 years! Originally, floodplain forests along the Lower Rhine were up to 15 km wide, vast reedy areas, swamps and lakes covered the Rhine estuary. Centuries ago, the floodplain forests along the Lower Rhine were developed into meadows. Only 2.3 % of the 160 km<sup>2</sup> of remnant floodplains along the Northrhine-Westphalian Lower Rhine are still near to nature. The big **mammal species**, such as moose, aurochs, bear and wolf which formerly prowled through the floodplain forests along the Rhine disappeared in the Middle Ages. Beaver and otter were almost extirpated in the 19th century. Today, the number of beavers is increasing. They build their lodges on the Alp Rhine, the High Rhine, the Upper Rhine and in the Rhine delta.

**The floodplains along the Rhine are not yet lost.** Contrary to many rain forests, floodplain forests can regenerate, even if it takes more than 200 years to develop a mature hardwood-floodplain vegetation. Afforestation would not lead to natural floodplain forests. Too high water retention levels harm the floodplain forest, as its roots and bottom dwelling animals die of a lack of oxygen. New floodplain forests along the Rhine need time and space regularly inundated by floods, in which floods may widely spread, rise and sink according to a natural rhythm, like the "breath of floodplains".



Beaver





Alfons Paquet (1923):  
A landscape like that  
of the Rhine ... bears  
the dream of its ideal  
form uniting nations  
as a seed in itself.

### 3. Actions for the Rhine? – How we save relationships

The first aid actions for the Rhine have been successful. Thanks to vast investments into wastewater treatment, the river may breathe again. It is much better, but not cured. The ICPR recommends further operations. Obstacles must be removed from the circuit, green lungs must be transplanted, backwaters reconnected. And what is more?

Sustainable management uses the resources in cycles and avoids interventions and pollutant emissions. This is the royal course the ICPR proposes – in its programme "Rhine 2020". The new environmental legislation of the European Union points in the same direction.

This is how the vision of a united Europe takes shape in Rhine protection.

#### Successful first aid

So far, the ICPR *Action Programmes* have achieved most in the field of water quality. The oxygen content of Rhine water is almost optimal. The inputs of important pollutants have successfully been reduced by far more than 50 %. Problems still exist related to "diffuse", that is non point inputs of **heavy metals, nutrients** and new organic trace constituents. These are residues of modern high-tech chemistry from applications in agriculture, insecticides, medicine, hygiene and clothing. It is only recently that **micro-pollutions** can be detected in micro- and nanogram per litre of water.

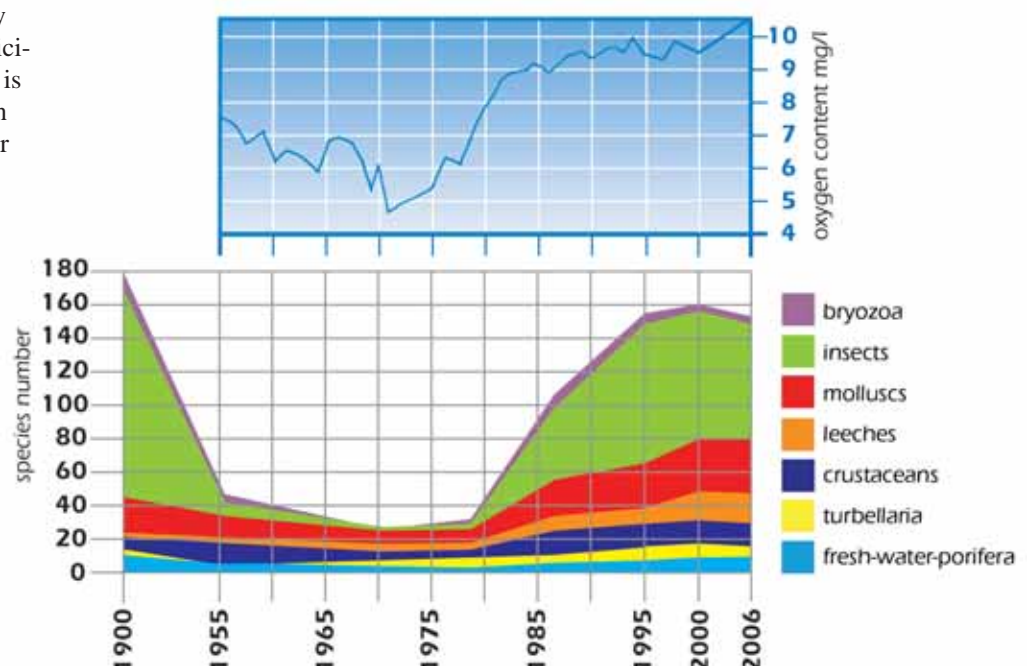
#### Micro-pollutant sources:

- Biocides
- Pharmaceutical products
- Personal care products
- Cleaning agents
- Textiles

Low concentrations of these hazardous substances have effects and may accumulate in living organisms. The ICPR is drafting a strategy aimed at reducing these substance inputs from agriculture, municipal and industrial wastewater. The **memory of rivers** is another problem. Remnants of pollutant masses of the past decades have settled on the bottom of the Rhine and pose a threat to

water quality. Therefore, the ICPR is drafting a sediment management plan for the entire Rhine area. It will list "Hot Spots" or "areas at risk" as well as the most urgent measures.

A completely clean Rhine will probably remain utopia. But good water quality is a prerequisite for a living river.





## EU water framework directive of 2000

- focuses on water biology
- requires the good chemical and ecological state of all European waters by 2015

## Operation living river is going on

So, in the meantime, Rhine chemistry is almost as it is supposed to be, but this is not true of the ecological state. Water quality has considerably improved, but the river cannot flow freely, it is too narrow, its banks are monotonous and often artificial. Only when the river may spread wider and migrating animals may again migrate will "the beautiful and abundant life return", as the water scientist Rolf-Dieter Wilken put his vision of the Rhine.

The ICPR programme Rhine 2020 is targeted at improving the Rhine ecosystem to such an extent that salmon and other migratory fish can again constitute stable wild-living stocks by the year 2020.

### Actions for Rhine 2020

1. Restore habitats
2. Activate floodplains
3. Improve river structure
4. Remove migration obstacles
5. Near to nature connection of habitats

In 2006, the ICPR presented a plan for creating a network of habitats in the floodplains of the Rhine between Lake Constance and the North Sea. The objective is to conserve and restore biological diversity. The ICPR aims at protecting natural areas along the Rhine and its tributaries, at re-naturing as many points of disturbance and at re-connecting scattered habitats in the river corridor. To this end, floodplains are reactivated in the Rhine bordering countries, oxbow lakes are re-connected, fish migration obstacles are removed and nature near habitats are restored and developed for organisms typical of the Rhine.

The results of the programmes on migratory fish in the Rhine river system which started as "Salmon 2000" and is being continued within "Rhine 2020" are impressive, in particular concerning the reintroduction of the extinct Rhine salmon. It is proven that, since 1990, more than 5,000 adult salmon have returned from the North Sea and migrated upstream the Rhine.

The eel – another migratory fish species – will in future benefit from the implementation of the EU eel-regulation.

Thanks to joint German and French efforts, the Iffezheim fish passage was opened in 2000. Between 2001 and 2004, three new fish passages have been accomplished in the Rhine delta. In 2006, the Gamsheim fish passage was opened

on the Upper Rhine. But the four dams at Strasbourg, Gerstheim, Rhinau and Marckolsheim continue to lock the way upstream. Further upstream, the German-French Old Rhine could serve as bypass for migratory fish.

On the High Rhine, 10 of the 11 power plants are equipped with functioning fish passages. During the next years, some of them will be improved and additional bypass waters will be constructed. Until 2015, the Haringvliet locks in the Rhine delta will partly be opened. The continuity of the Rhine for migratory fish from the North Sea to the tributaries at Basel remains an ambitious target.



Atlantic salmon

**Paul Baron (1996):**  
*Having been a source of discord, will the river in future unite the nations? The return of the salmon is a sign of progress in the right direction.*



## Flood protection by room for the river

Floods and low water are part of the natural hydrologic cycle. Rhine discharges vary with glacier and snow melting as well as with precipitations and water uptake in the watershed.

However, today floods of the Rhine discharge more rapidly and are higher than in times before the construction of dams and they often overlap with flood waves in the tributaries. And our settlements have drawn too close up to the rivers.

Additionally, due to the impact of climate change, water levels will be much higher during future extreme situations.

**Heinrich Böll (1960):**

*And I am still afraid of the Rhine, ... murmuring so gently and weirdly through children's dreams, a gloomy god claiming to have proved that he still demands victims: heathen, nature, no signs of charm, it spreads as wide as the sea, penetrates into apartments, greenishly rises in the cellars, surges from the canals, roars below the arches of the bridges: Undine's formidable father.*

Formerly, flood protection measures were local, always meant the construction of dikes and defensive walls. Today we know that these measures increase the impact of floods downstream. Along the Upper Rhine, the discharge section has been reduced from a width of about 12 km to some 200 – 250 m, the course of the Rhine has been shortened by 82 km, the mere construction of dams has reduced the surface of the floodplains by 130 km<sup>2</sup> and the travel time of the flood surge between Basel and Karlsruhe has been reduced from 64 to 23 hours. River training has shortened the German section of the Lower Rhine by 23 km. Today, the Rhine disposes of less than 15 % of the original flood plain.



Cologne 1993/95





Hans Dieter Hüsich (1984)  
 on the Lower Rhine:  
*Homberg*  
*My grandparents' world*  
*on my father's side*  
*The warm little house*  
*which drowned several times*  
*when the Rhine topped its banks*  
*rolled across the fields*  
*penetrated the houses*  
*and people sat on the roofs*  
*resigned and poor*  
*and started all over again:*  
*What else is there to do*

A landscape with extensive residential areas, industry, intensive agriculture and damaged forests retains less water. That is why "centennial floods" occur distinctly more often along the Rhine. An extreme flood of the Rhine like that of 1882/83 due to several days' rain on frozen soil would be even more disastrous today and top the dikes.

Flood crests must thus be cut. Along the Rhine, this is only possible by giving more "**room to the river**", that is, by relocating dikes or by creating retention areas behind the dikes. Since 1995, renaturation has created 33 km<sup>2</sup> of "new" floodplains. Many more retention areas must be created.



**Floodplains along the Rhine**

formerly: 8.000 km<sup>2</sup> (100,0%)  
 1995: 1.200 km<sup>2</sup> (15,0%)  
 2020: +125 km<sup>2</sup> (1,6%)

Deventer on the Ijssel, Netherlands, 1995







Extreme floods  
 put at risk 10,700,000  
 people along the Rhine  
 165 bn Euro of assets

The ICPR drafted an  
**Action Plan on Floods**

*"including the target of ecological improvement of the Rhine and its floodplain"* and, in 1998, the Rhine Ministers decided to implement this plan. In the meantime, the ICPR has drawn an intermediate balance: Until 2005, important action targets have been achieved, as different measures entailing costs of 4,5 bn Euros have been implemented. The riparian states have created great retention areas for 77 million m<sup>3</sup> of flood water along the main stream, as they are most effective in order to reduce extreme flood stages.

Agriculture and forestry considerate of the soil, unsealing surfaces, enhance rainwater seepage and re-nature running waters represent further **flood mitigation** measures in the Rhine watershed. Forests must be preserved and managed near to nature, as they store water, set it free with delay and protect against erosion.

**Balance  
 Action Plan  
 on Floods**

Action targets	Objective (2005/2020)	Results (1995-2005)
1. Reduce damage risks	10% / 25%	30% along non diked stretches 10% along diked stretches
2. Reduce gauges	30 cm / 70 cm	30 cm Maxau gauging station less downstream
3. Increase awareness	Maps of flood danger and risk	ICPR Rhine atlas 2001
4. Improve announcement	long term by 100%	100 %, but not as reliable as short term announcement



## Rhine protection in the 21<sup>st</sup> century

### The water of life

... I still remember a means,  
the water of life;  
if he will drink it,  
he will get well again:  
but it is hard to find.  
Grimm's fairy tales  
(1814)

Much has changed due to the restoration of the Rhine. All riparians discharge less waste and have additionally begun, not just to transfer downstream problems caused by floods.

According to the new *Flood management directive* (2007/60/EG) flood prevention measures must be internationally co-ordinated in all transboundary river basin districts of the EU. In the river basin of the Rhine, the ICPR will co-ordinate this work.

The *Water Framework Directive* (WFD-2000/60/EC) also requires co-ordinated management for European water bodies. Great rivers and their floodplains will be managed on the basis of river basins, taking into account the interaction between surface and groundwater. Preferably, protection and use are to be harmonized. By 2015, all European water bodies are supposed to have achieved the good chemical and ecological state. The ICPR supports the EU Member States in implementing the requirements of the WFD.

Birds demonstrate the ecological quality of waters:  
Where the common sandpiper breeds, river bank structures are near to nature.

Today's EU *agricultural policy* partly links subsidies to ecological achievement (Cross compliance). In this connection, the Swiss law on agriculture provides for direct payment.

*Ecological agriculture* serves the objectives of water and nature protection, as it aims at using closed substance circuits, at adapting stock density to the size of the surface and at fertilization taking into account plant requirements.



*River bank strips* and hedges protect against erosion and rainwash from intensive farming and reduce the drift of fertilizer and plant protection agents by wind protection.

In floodplains, *grassland farming* is to be preferred to field cropping, as, from grassland, only a fraction of the tons of humus soil eroded from fields is washed off into the floodplains. In the floodplains of brooks and rivers, as many fields as possible should be converted into grassland, near water bodies into forests.

The **EU and the ICPR** join forces and continue their holistic water policy. The path is difficult and it is not easy to achieve the objective, but, just as in a fairy tale, it is worth the effort – a Rhine of life





## A Rhine of life

In 2001, the Rhine Ministers adopted the new programme on the sustainable development, "Rhine 2020" in Strasbourg. It unites objectives which used to be considered as opposites: Use and restoration, flood protection and nature protection. If we wish to use the Rhine sustainably, we need to restore it. Opening sufficient surfaces for the Rhine, allowing the river to top the banks means, protecting our settlements in the valley against floods. At the same time, inundation areas may develop back to nature near floodplains and reconnect to the network system in the river landscape.



Targets of the UC convention on biological diversity (1992):

1. Conservation
2. Sustainable use
3. Equal sharing of advantages of use

*Renaturing or restablishing* running water bodies means to **restore the ecological system** consisting of source-brook-river-riverbed-floodplain-groundwater and to remove transverse and longitudinal structures. Ideally, nature may then design. During floods, brooks seek new paths, plants and animals settle. If we give back room to brooks and rivers, this will again be possible. Along the Rhine, too, it is possible to at least partly loosen up the rigid corset and give a chance to more floodplain forests.

Little ringed plover



### Floodplain forests and riverside shrubbery

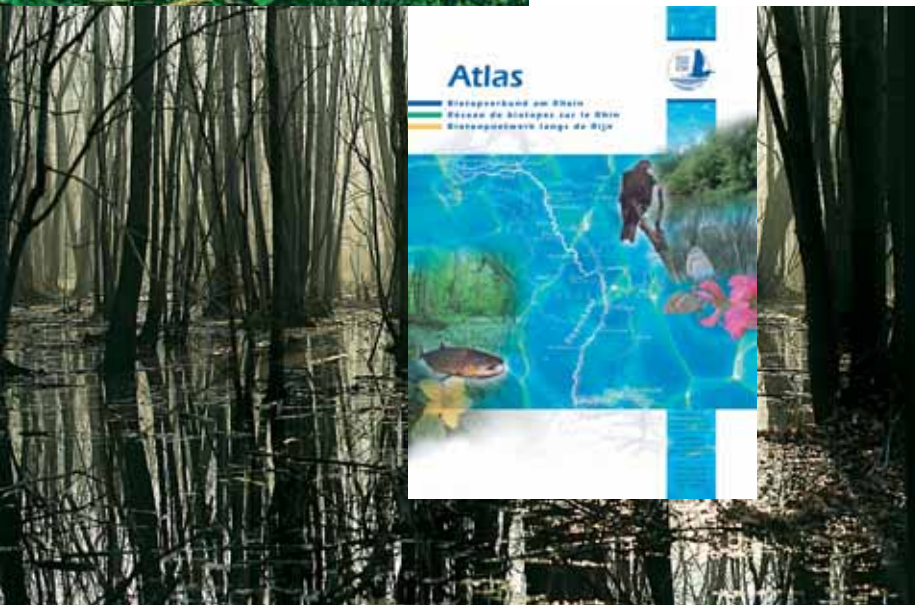
- filter and clean floodwater,
- recharge groundwater,
- protect against lapping of waves and erosion,
- suck water like swamps,
- break flood crests,
- tolerate long periods of floods running off on the surface (silver willows up to 190 days, English oak up to 97 days a year)
- belong to the most precious and most endangered types of habitat in Europe







Along the Rhine, **the areas of importance under the aspect of nature protection** have been surveyed according to types of habitats, such as sand and gravel banks, moors and floodplain forests. In 2006, the ICPR published a *Rhine Atlas*. An accompanying brochure presented the actual and the target state in detail. Measures aimed at reactivating floodplains, e.g. by relocating dikes and reducing intensive use were determined for different surfaces. Floodplain habitats, which used to be interconnected, are again to be connected to a network. This *habitat patch connectivity* along the Rhine will be part of a European network of habitats, e.g. within NATURA 2000. The implementation requires joint action of nature protection, water protection and water management.



The Rhine has extensive connections with its surroundings. Via the **North Sea** it is connected with the oceans and vice versa. Many connections are related to the life cycle of migratory fish and to the transportation of substances in water. Young salmon leave the Rhine for the Atlantic Ocean, where they feed and grow until they are mature enough to return to the Rhine. With a view to facilitating the restoration of the stocks of salmon and sea trout in the Rhine, the countries bordering the North Sea decided, on their **fisheries conference** in 1997 in Bergen, to support an interdiction of salmon and sea trout catches in coastal and marine areas. Since 2000, this interdiction also applies to Dutch coastal waters and inland waters. In the end, Rhine pollution pours into the sea, excessive nutrient inputs overfertilize the water, pollutants accumulate in marine organisms and drift eastwards into the Wadden Sea.



**The Wadden Sea** stretching from the Netherlands via Germany to Denmark figures among the most important wetlands of the world, it is a "nursery ground" for fish, resting place for almost all waders and waterfowl from Greenland to Siberia and habitat for piscivores at the end of the food chain, e.g. the seal. After a most threatening decline in stock due to illness, this mammal species has now recovered. Who knows, whether a cleaner Rhine has contributed to this recovery.



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Since the UN conference in Rio de Janeiro in 1992, the political objective for almost 200 states of our planet is **sustainable development.**

With respect to the Rhine, this means

## 1. social



## 2. economic



## 3. ecological

development of the river so that, in future, people in the watershed will have a chance of leading a good life. The magical triangle of sustainability is the symbol of an ideal – almost as unattainable as trying to square the circle. But it is quite certain that nature and its resources support and limit our economic and social development – along the Rhine just as elsewhere.



# Dialogue with the Rhine

Joost van den Vondel (1629)

"De Rijnstroom":  
*Illustrious Rhine! My sweet dream!  
Where shall your poets stand  
and praise you? Home river!  
Coming from the Swiss Alps  
Artery of Europe ...*

**Poets call the Rhine *illustrious* (Vondel 1629), *born free* (Hölderlin 1801), *proud and noble* (Hugo 1836), *sovereign* (Böll 1960). This of course is not the language used by technicians solving partial problems along the Rhine.**

**Artists see the river as a whole.**

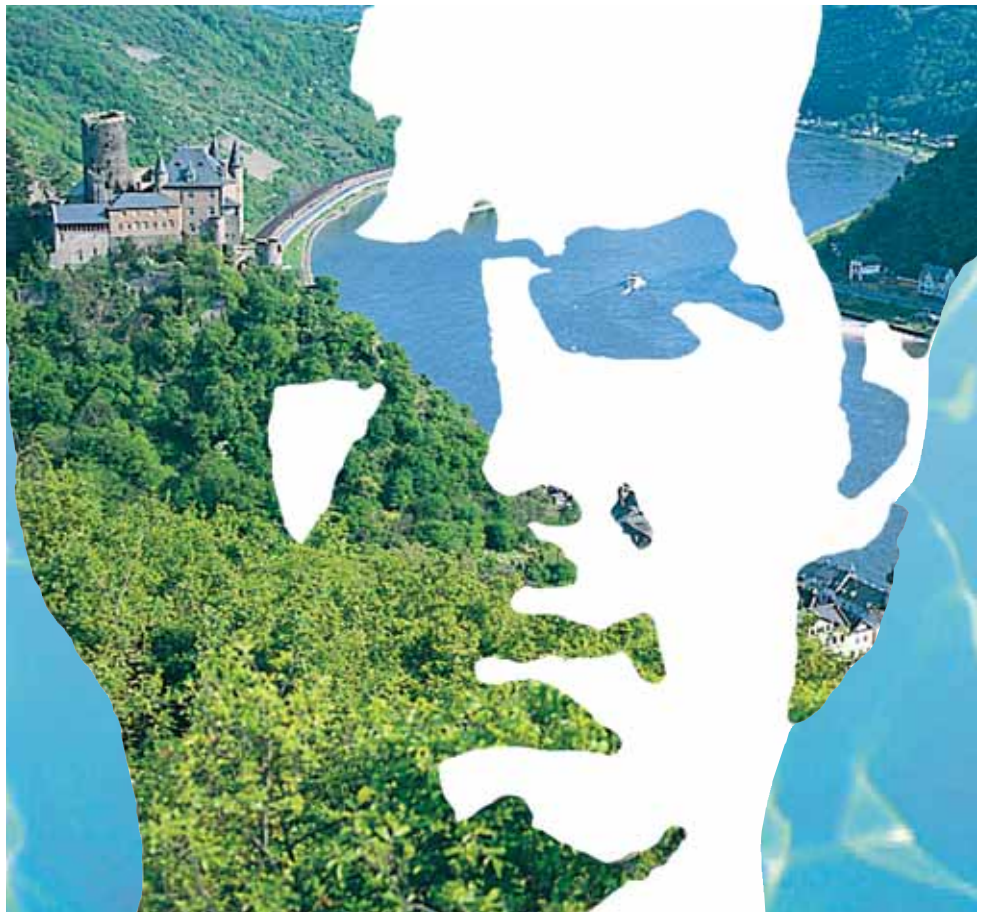
**Ecologist try the same thing in their way. And what do water politicians do along the Rhine and throughout Europe? They accomplish a quantum transition towards global and sustainable water protection. A Must in times of climate change.**

Who is to accomplish holistic water protection along the Rhine? We can only do it together – with scientists, state administrations and private organizations. Since

1998, the ICPR associates different associations acting in economy, municipalities and nature protection to its work. The European Water Framework Directive also requires public participation. The objective is to achieve a maximum consensus before implementing planned measures. People living along and of the Rhine must decide in favour of the river, formulate common targets, act in common and take common responsibility.

There is no need for worshipping the Rhine, but we might treat the river and its landscape with more respect and care. We would then turn towards a culture which is fitter for the future, for us and for our children along the Rhine.

Wolfgang Erz (1995):  
*Nature protection is only possible on the basis of humanity, a humanity without frontiers – between the states and in everybody's head.*



Heinrich Heine (1844):

*Be satisfied, Father Rhine,  
do not think of bad songs  
soon you will hear a better song  
farewell – we'll see again.*