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Fifty years of the Rhine commission : A success story in nutrient reduction

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This edition of the SCOPE Newsletter presents fifty years' action of the Rhine Commission, 1950-2000. We tell the story of how international co-operation through the Commission has restored the Rhine, from the point where most life had disappeared, to a state where salmon have returned to breed, migrating some 700 km up the river. 90% reductions have been achieved for many priority pollutants. We concentrate on one specific aspect of the Rhine's water quality: nutrient discharges and concentrations, and find that the successful reduction in phosphorus concentrations has not been matched for nitrogen. We conclude by looking to the future and to areas where further action is needed and to the Rhine Sustainable Development 2020 programme.

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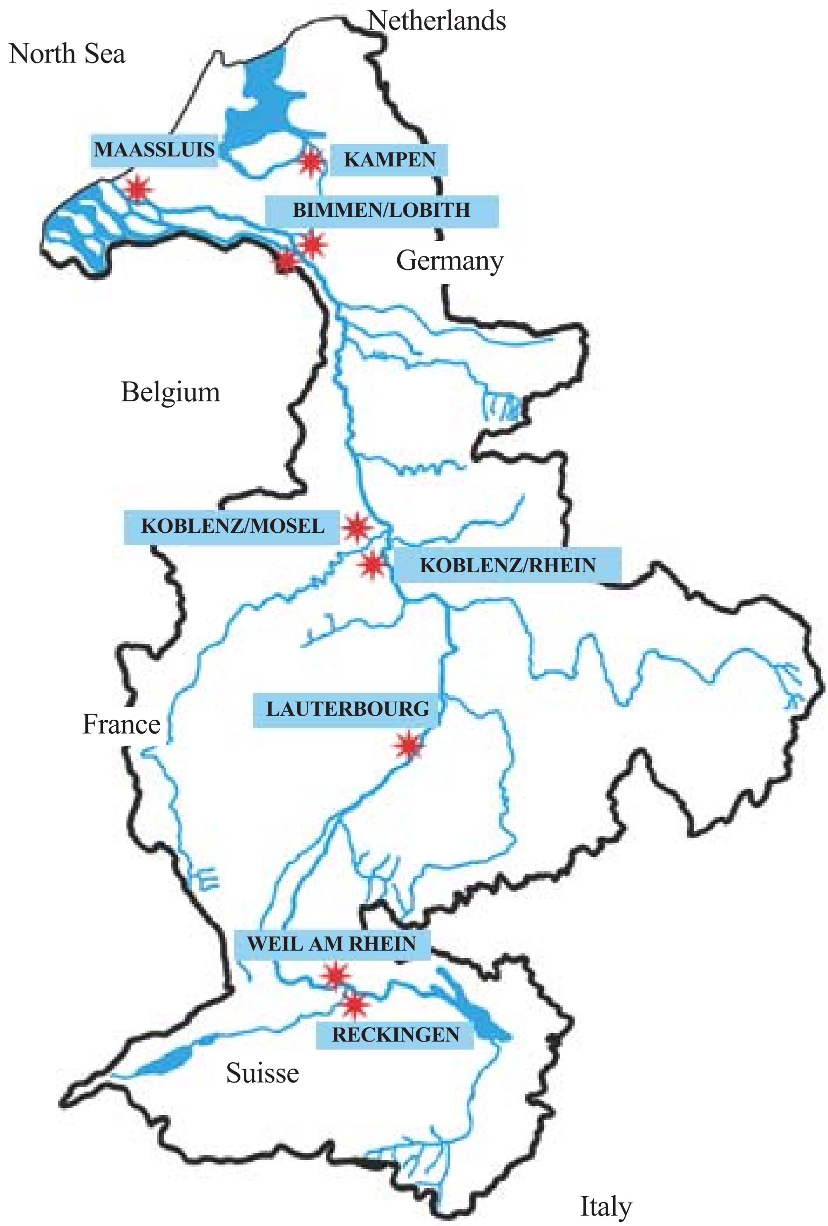

*Map of the Rhine Catchment (approx 200,000 km²) showing the * main water quality monitoring points referred to in this Newsletter.*

INTRODUCTION

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The River Rhine is one of Europe's most important and famous rivers. Originating in Switzerland it is 1,320 km long and flows via France, Germany and the Netherlands to the North Sea. With its tributary rivers it has a catchment of around 200,000 km^2. The river has been central to western European culture – from its time as a major corridor for the movement of prehistoric peoples and the effective boundary of the Roman Empire to is later role as a major shipping route and artery of commerce. It has been the source of inspiration for poets and writers and formed the centre for the early industrialisation of this region of Europe. While twelve other rivers in Europe have larger catchments than the Rhine, the river is probably only rivalled by the Danube in the underlying consciousness of European culture.

The Rhine catchment has acted as a significant source of settlement for many centuries. The Romans built the first important towns and cities in the region and later settlements thrived as the area acted as a major commercial, cultural and political cross-roads. Today the Rhine catchment holds a population of around 50 million people. Many benefit from the river itself, not least from commercial shipping – the Rhine being the most dense shipping route in Europe. At the mouth of the river lies the largest sea port in the world – Rotterdam – and this connects to the world's largest inland port at Duisburg. Industrialisation has grown considerably resulting in huge industrial complexes, such as those found in the Ruhr, Main and Rijnmond areas. A wide range of industrial activity is undertaken. For example, Europe's most important chemical plants are found along the river.

The transport opportunities are only part of the use to which the Rhine is put. For many years it has acted as a source of drinking water (today supplying over 20 million people), waste water disposal, energy generation and recreation.

This has created enormous pressures on the environment of the Rhine. However, it still remains an important location for many wildlife habitats as well as a corridor for species migration.

This edition of the SCOPE Newsletter is produced to mark fifty years of the Rhine Commission. It tells the story of the degradation of the Rhine to the point where most life disappeared and how international co-operation through the Commission developed ways to reduce pressures and restore the river. After providing a general overview of these issues, we concentrate on one specific aspect of the Rhine's water quality: nutrient discharges and concentrations. Finally, even though much has been achieved, such tasks are never finished. This Newsletter, therefore, concludes with a view to the future and what action remains to be undertaken.

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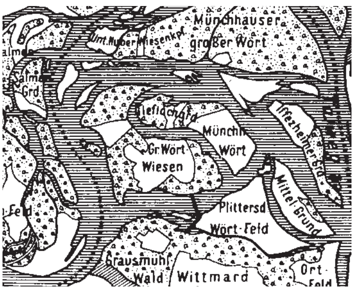
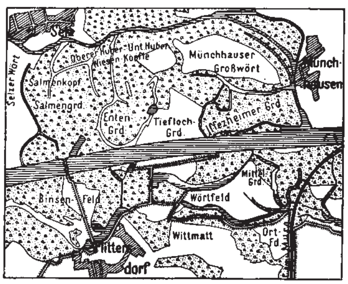
The deterioration of the Rhine

Centuries of human settlement and manipulation of the river have, not surprisingly, resulted in the degradation of the environment. It is also clear that conflicts can arise in the role of the Rhine for human purposes, eg between its role as a drinking water source and its use for waste water disposal.

Degradation started early. One of the earliest records of problems in the environment was noted in 1449. The effects of overfishing and of pollution had led to significant declines in the fish population. As a result the so called 'Strasbourg Regulations' were adopted. These formed the first international agreement to protect the Rhine. However, many more changes to the environment were to take place, before improvements would be seen.

One of the most dramatic changes to the river occurred between 1817 and 1874. During this period the German engineer Tulla undertook a major series of engineering works to alter the structure of the river channel. This included straightening of the river course, as well as numerous other riparian measures. The action was undertaken to improve navigation, reduce flooding, recover alluvial areas for farming and reduce incidents of disease. These changes (so called 'corrections') have continued since, well into the 20th century. The result of these changes was that the length of the river was dramatically shortened. Between Basel and the border of Hessen alone, the length of the river was reduced by 80 km.





Disappearance of tressing of the Rhine river near Pittersdorf, Upper Rhine, from 1817 to 1874, leading to loss of habitat diversity, fish spawning grounds, water purification capacity and other natural functions

Engineering works did not only focus on the river channel. The large volumes of water flowing down the river has proved attractive as an energy source. Along much of the Rhine many dams and weirs were constructed to hold water for power generation.

Overall the physical character of the river changed significantly. Meanders were cut off, flood plains reduced or lost and flow velocity generally increased. These effects also resulted in increased erosion in surrounding areas and a lowering of groundwater levels. Numerous important habitats were lost and the physical barriers erected across the river prevented the movement of migratory fish such as the Salmon. In 1870 the total catch of Atlantic Salmon on the river was 280,000. By 1950 this was reduced to zero.

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Not all losses were the result of physical changes – pollution also had a large role. Amazingly, even though pollution problems had been highlighted in 1449, it was not until the 1960s that the issue became of high enough profile for action to be considered. However, by this stage water quality had deteriorated to the point that little aquatic life remained along much of the river. Discharges of organic wastes (eg from sewage) had reduced oxygen levels to below 2 mg/l, industrial discharges included large quantities of heavy metals, hydrocarbons, organochlorine compounds, pesticides, etc. Sediments became highly contaminated. Those providing drinking water had to employ increasingly more complex and expensive treatment methods. The river had become the sewer of Europe, as was noted by the poet Allen Ginsberg who, in 1979, published:

> *'Too much industry*
> *No fish in the Rhine*
> *Lorelei poisoned*
> *Too much embarrassment.'*

International co-operation: the creation of the Rhine Commission

Solving the problems of the Rhine was only possible through international co-operation. The Rhine catchment states (Switzerland, France, Germany, Luxembourg and the Netherlands), therefore, established the International

Commission for the Protection of the Rhine (ICPR) in Basel on 11 July 1950. Co-operation was strengthened particularly in 1963 with the signing of the Berne Convention on the Protection of the Rhine. The European Community formally signed this Convention also, in 1976. This SCOPE Newsletter, therefore, examines the achievements of the Rhine Commission to its fiftieth anniversary in 2000.

The first internationally agreed measures to tackle pollution in the Rhine were taken around 1970. This was twenty years after the creation of the Commission and, as we have seen, there was already significant evidence for environmental problems. It is not, therefore, unreasonable to ask – why the delay? The two main reasons usually given are that it took some time for mutual confidence building and co-operative mechanisms to be developed between the states and, more importantly, political commitment to tackling environmental issues was very weak until the late 1960s. It is often stated that the Torrey Cannyon oil tanker disaster in the English Channel highlighted environmental concerns and certainly, by 1974 a range of international conventions had been signed, such as the Marpol, Oslo and Paris Conventions. National governments were, therefore, willing to take necessary action.

Thus the 1970s and early 1980s saw a spate of activity in the Rhine catchment to reduce pollution. For example, between 1970 and 1985 more than Eur. 40,000 million were invested on industrial and municipal waste water treatment. The focus was on end-of-pipe techniques, rather than on preventive measures. The reduction in organic inputs led to a steady improvement in dissolved oxygen levels.

In 1976 the Rhine Commission adopted an International Convention on the Prevention of Chemical Pollution of the Rhine. This focused on a list of dangerous substances, in part taking forward the European Economic Community's 1976 dangerous substances Directive. Limit values for specific substances were agreed between the Rhine bordering states, but, due to potential consequences for the internal market, it was considered necessary for these to be developed by the EEC. Unfortunately, after some initial activity, progress became painfully slow and eventually ground to a halt at the Community level. The problem has been the very slow conversion of the ICPR-Recommendations for the reduction of single substances, in national law and the long list of substances (single substance approach in contrast to the BAT approach for industrial sectors).

Thus the 1970s and early 1980s saw some important initial action to reduce pollution to the Rhine. However, the initial impetus had become stuck in a mire of political disagreements which was leaving some issues unresolved and others making only slow progress. It took a major disaster to shock the national governments back into action.

The 1986 Sandoz accident: the creation of the Rhine Action Programme

The accident at the Sandoz plant near Basel resulted in the release of large quantities of toxic substances into the Rhine. These caused the death of almost all aquatic life for many kilometres downstream as far as the Lorelei, just upstream of Koblenz. The effect was equally dramatic politically, with popular concern heightened in all the Rhine states. In a short time three ministerial conferences had taken place addressing pollution to the river. These culminated in the 1987 Rhine Action Programme. The development of the Rhine Action Programme in so short a space of time contrasts markedly with the slow progress of previous years. Apart from the urgency felt from the Sandoz accident, it was also facilitated by environmental issues rising generally on the political agenda and, not least, by the preparatory work that the Rhine Commission had been able to undertake. The Rhine Action Programme marks an important step in international water management. It was by far the most detailed river basin programme agreed between sovereign states anywhere in the world.

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The Rhine Action Programme set out a series of broad and challenging goals for the period up to the year 2000. These supported an integrated approach to river management, not merely tackling specific pollutants, but aiming to improve the entire ecosystem. The specific goals were:

- the ecosystem of the Rhine should be improved sufficiently for species such as salmon and sea trout to re-establish breeding populations;
- the production of drinking water from the Rhine should be guaranteed for the future;
- the pollution of river sediments should be reduced to levels compatible with the use of sludge for landfill or sea dumping.

The Rhine Action Programme also established more specific objectives to underpin these broad goals, such as that of reducing the input of dangerous substances to the river by 50% between 1985 and 1995. Concerns were again hightened in 1988 when enormous algal blooms occurred in the North Sea related to nutrient discharges from the mouth of the Rhine. As a result the Rhine Action Programme added a further broad objective for 2000:

- The improvement of the ecological state of the North Sea.

The Rhine Action Programme was divided into three phases:

1. The Rhine Commission established a list of priority substances, including nutrients, analysing sources and discharges. It also developed a best available technology (BAT) approach to preventive measures for industrial and municipal discharges. Measures were also adopted to reduce the risk of pollution from accidents.
2. The second phase (to 1995) focused on the implementation of measures developed in the first phase;
3. The third phase (to 2000) focused on 'fine-tuning' – identifying any additional measures necessary to tackle problems that may have remained.

Box 1: Key dates in the history of the Rhine Commission

1950: Following a Dutch initiative the Rhine bordering states created a common forum to discuss issues relating to pollution of the river.

1963: Signature of the Convention on the International Commission for the Protection of the Rhine against Pollution (Bern Convention) by the Rhine bordering states.

1976: European Community joins as contracting party to the Bern Convention.

1976: Signature of the Convention on the Protection of the Rhine against Chemical Pollution and signature of the Convention on the Protection of the Rhine against Chloride Pollution.

1987: Ministers approve implementation of the Rhine Action Programme.

1995: Ministerial decision to draft an Action Plan on flood control measures.

1998: 12th Conference of Rhine Ministers agrees Action Plan on Flood Defence and New Convention on the Rhine.

2001: 13th Conference of Rhine Ministers : adoption of the Rhine Sustainable Development Programme "Rhine 2020"

The organisation of the Rhine Commission

The organisational structure of the Rhine Commission has changed and evolved over the many years of its existence. The last major change occurred in 1995, with the introduction of action in relation to flood management. The political goals of the Rhine Commission are set through Ministerial conferences, which are held every two to three years. These also assess and evaluate the activities which the Rhine Commission was charged with undertaking. The Commission itself consists of senior officials from the member states. It meets annually and decides on work programmes, finances and formal procedures. A co-ordination group, meeting four times per year, is responsible for the actual planning and co-ordination of the work of the Rhine Commission.

The Commission has three permanent working groups which address the issues of water quality, ecology and emissions. The work of these groups is described in box 2. There is also one non-permanent project group which has a time-limited mandate and supervises the implementation of the Action Programme on Protection against flooding. The work of these groups is also supported by expert groups of national officials which address specific issues. The work of the Commission is supported by a small international secretariat based in Koblenz, Germany.

Box 2: The tasks of the three Working Groups of the Rhine Commission

Working Group A: Water Quality

- Supervises the development of the quality objectives for water, suspended matter, sediments and of residues in organisms.
- Develops research programmes and evaluates the results.
- Assesses unusual concentrations of noxious substances through a variety of monitoring systems and tests.
- Evaluates and reports on monitoring results.
- Periodically compares the state of the Rhine with target values.

Working Group B: Ecology

- Elaboration of the Ecological Master Plan for the Rhine in the context of integrated ecological protection.
- Drafting guidelines for a network of biotopes in the Rhine corridor and of proposals for necessary measures.
- Support and completion of the Salmon 2000 programme.
- Support and evaluation of ecological success.

Working Group C: Emissions

- Registration of sources of pollution and proposal of appropriate reduction measures, including, if necessary, economic incentives for point and non-point sources;
- Harmonisation of the Best Available Technology for significant industrial sectors along the Rhine and monitoring its application;
- Prevention of accidents and improvement of safety of industrial plants.

Management issues and achievements

The nature of the problems relating to nutrient discharges and actions to tackle these will be discussed in detail in a later section. However, it is important to highlight action on the range of issues that the Rhine Action Programme addressed and were managed by the Rhine Commission. This illustrates the integrated river basin management approach.

Accident management and industrial pollution reduction

The management of accident prevention and containment is highly site specific. However, it is also important for management at the river basin level. In 1987 Ministers asked the Rhine Commission to develop a model to allow rapid and reliable prediction of how pollutants would travel along the river in the event of another accident. The Rhine Commission worked with the International Commission for the Hydrology of the Rhine and the Universities of Delft, Freiburg and Bern. As a result a model is available that can predict the timing of maximum pollutant concentrations following an accident, allowing for measures to be taken to reduce or avoid its effects. The model includes the Rhine from its outflow at Lake Constance to the Netherlands, including the estuarine rivers Ijssel, Nederrijn and Waal (although not tidal reaches), the tributaries of the Aare, Neckar, Main and Moselle, and the influence of standing waters.

The Rhine Commission also undertook a comprehensive inventory of all of the industrial plants along the Rhine which, in the event of an accident, could release significant pollution into the river. National authorities remained responsible for safety inspection. This work resulted in the Rhine Commission report ‘Prevention of Accidental Pollution and Safety of Industrial Plants’. Since its publication the Rhine Commission has made a variety of recommendations concerning safety and the prevention of accidental pollution. Such recommendations included a focus on day to day pollution minimisation as well as prevention of major accidents.

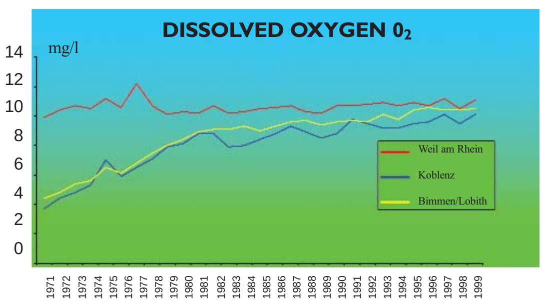


Figure 1. Dissolved oxygen concentrations at three locations along the Rhine 1971-1999.
See map page 2 for location of these sampling points.

To tackle industrial discharges, especially of toxic substances, the promotion of Best Available Technology (BAT) in pollution prevention has been important. BAT concerns improvements to industrial processes themselves (to reduce the likelihood of pollution production) as well as effective 'end-of-pipe' technologies to treat waste water prior to discharge. The Rhine Commission has assisted in the exchange of information on BAT between the Rhine bordering states and monitors its application.

These aspects of the Rhine Action Programme have been very successful. By 1994 the Rhine Commission reported that the 50% target for 1995 for the reduction in discharge of dangerous substances had been met in most cases and 90% reduction had been achieved for many. However, some problems remained, particularly for diffuse sources such as pesticides and nutrients from agriculture. However, the improvement has been dramatic in a short time.

Developing quality objectives

Effective management requires objectives. The Rhine Commission has, therefore, developed a system of quality objectives for the Rhine. These so called ‘Zielvorgaben quality targets’ are not absolute emission limits or ambient quality values. Their aim is to provide an easy quantitative assessment of the river quality and to act as a tool for priority setting when specific measures are developed for individual substances. These ‘quality targets’ include the most stringent values, such as no effect concentrations (NOEC) for aquatic life and drinking water abstraction requirements derived from EC legislation. They include standards for fisheries, suspended solids and also for sediments. The ‘quality targets’ is set at the strictest level for the most sensitive objective. For example, the drinking water standard for chloroform is 1.0 mg/l. However, toxicity tests on aquatic organisms showed that effects were possible above 0.6 mg/l. As a result the ‘quality targets’ for chloroform has been set at 0.6 mg/l. Currently 80 (since the Year 2000) substances or groups of substances are included. The list includes a quality objective for phosphorus (0.15 mg/l), but not for nitrogen.

By the end of 1994 the implementation of the Rhine Action Programme meant that the objective concentrations for most substances (of the old list) were met. However, targets were not met for several metals (lead, mercury, cadmium, copper and zinc), for lindane, HCB and several PCBs and for ammonium. Many of these have significant diffuse sources or represent resuspension of contaminated sediments.

Reviving salmon populations

The Rhine Action Programme contained the objective of reviving sustainable salmon populations in the river by 2000. Salmon are an important indicator species for the general health of the river (requiring good quality water, spawning grounds and unhindered migratory access). They are also of importance to the public, which view the species as a symbol of the state of the river.

The Rhine Commission considered that different measures would need to be undertaken in a short time frame. The reduction in discharges of dangerous substances was a necessary prerequisite, ensuring water quality was adequate for fish survival. A particularly important objective in this regard has been that to increase dissolved oxygen levels. Measures to control organic discharges (especially from waste water treatment works) were introduced and dissolved oxygen levels have increased significantly (see Figure 1 - for details of the monitoring stations see below).

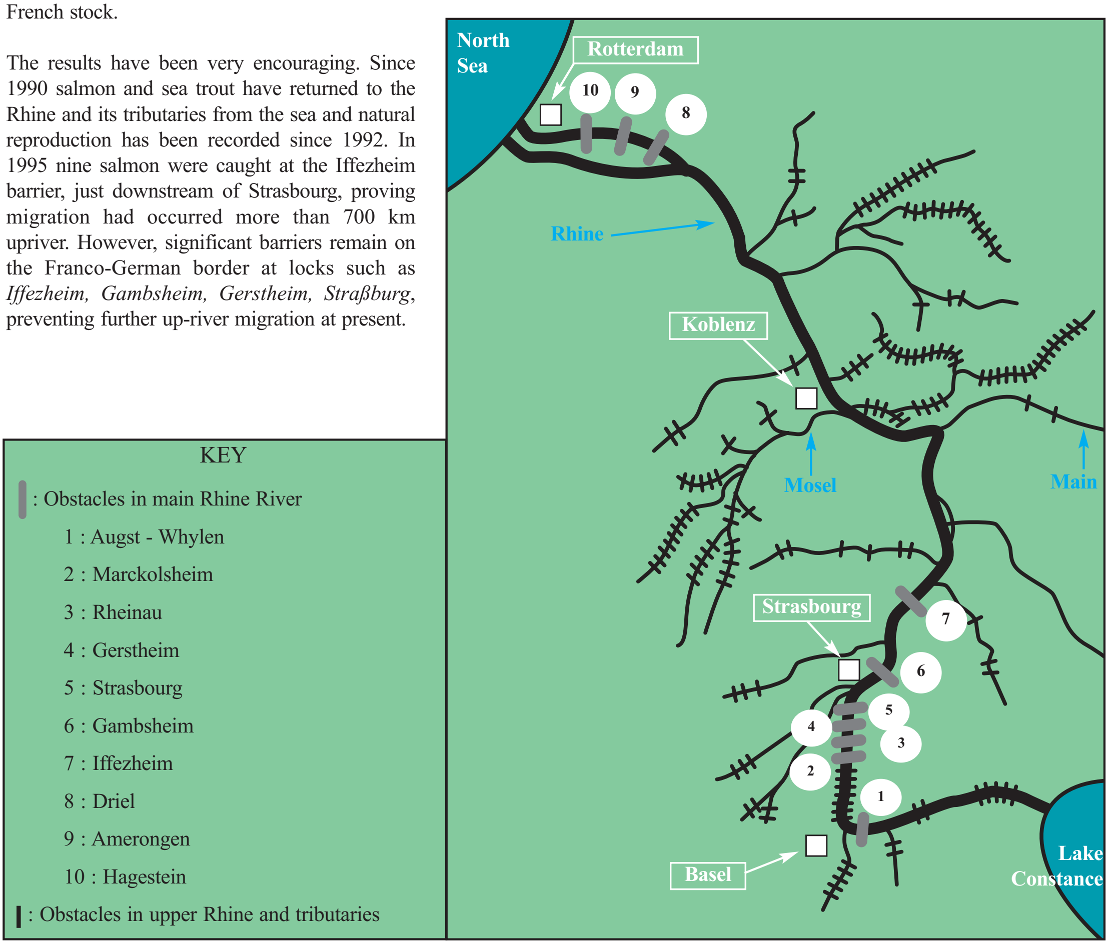
Additionally, the large number of engineering works undertaken since the early 19th century posed many barriers to fish migration. A programme introducing fish passages at the necessary barriers was begun. Habitat restoration work was also required at the spawning grounds to provide the necessary conditions for successful reproduction. The 'Salmon 2000' project of the Rhine Commission culminated in the introduction of thousands of alevins from Scottish and French stock.

The results have been very encouraging. Since 1990 salmon and sea trout have returned to the Rhine and its tributaries from the sea and natural reproduction has been recorded since 1992. In 1995 nine salmon were caught at the Iffezheim barrier, just downstream of Strasbourg, proving migration had occurred more than 700 km upriver. However, significant barriers remain on the Franco-German border at locks such as *Iffezheim, Gambsheim, Gerstheim, Straßburg*, preventing further up-river migration at present.

The importance of the Salmon 2000 project is not just the species' symbolic function. It represents an integrated management approach. Measures had to be developed covering water quality, engineering, habitat creation, etc, each of which needed translating from the scale of the river basin to that of local action. The lessons learnt from this successful approach can also be utilised in other areas.

Flood management

River management concerns not only qualitative issues, but also quantitative ones. In 1994 the Rhine Ministers broadened the scope of co-operation to include quantitative aspects of the management of the Rhine. This decision was, in part, precipitated by disastrous floods in the middle and lower Rhine in 1993 and the need for action was confirmed by further extensive flooding in 1995. The Rhine Commission, therefore, took on the task of developing an international action programme for the management of flood problems.



Map showing barriers to fish migration in the Rhine and tributaries

By 1995 the Commission had developed the first international strategy for the management of flooding problems. The primary conclusion of the strategy was that flooding could not be prevented and, therefore, that action should be focused on floodplain management rather than flood management. Ten guiding principles were formulated as the basis for a multi-track management approach. The Rhine Commission undertook a complete inventory of all historically known and present day naturally flooding areas, as well as an inventory of current international alarm and warning systems along the Rhine, in combination with the international network of meteorological stations.The management of flooding on the Rhine focused attention on the need for international co-operation as decisions taken at the local, regional or national level were often insufficient (or even counter productive). For example flood defences or urbanisation may simply create an even worse problem further downstream. However, a major challenge remains, especially in integrating the sensitivities of all of the authorities and communities involved. The focus on floodplain management also allowed greater integration with the ecosystem restoration objectives from other areas of the Rhine Commission's work.

Nutrient discharges to the Rhine

The two nutrients of most interest are phosphorus and nitrogen. Plants (both phytoplankton – that is "algae" - and macrophytes – that is larger water plants) are limited in their growth by various factors. These include the availability of nutrients. In freshwaters phosphorus is often limiting, while nitrogen is more usually the limiting nutrient in marine waters. For the Rhine discharges of both are of concern, given the need to protect both the river ecosystem and that of the area of the North Sea to which to river discharges. Other factors are also important. One of these is light. In areas of high concentrations of suspended solids light penetration in the water column can be severely limited and, therefore, elevated nutrient concentrations would have less impact. This can also be an important issue along parts of the Rhine.

The Rhine Commission has undertaken two full surveys of phosphorus and nitrogen inputs in the Rhine catchment in 1985 and 1996. The sources are divided into two general source types – point sources (such as a waste water treatment and works, industrial discharges) and diffuse sources (such as agricultural and other land surface run off and drainage).

Phosphorus sources

The data show (Table 1) that, in 1985, point sources accounted for about 75% of the total phosphorus input to the Rhine, with urban (ie sewage) discharges being about twice that of industrial inputs. By 1996 the relative importance of urban and industrial sources to each other remained similar. However, by this time the relative contribution of point and diffuse sources was roughly equal. Between 1985 and 1996 the total input of phosphorus from human activity reduced from 72,400 t P/a to about 25,400 t P/a. This is a reduction of about 65% and was well above the target in the Rhine Action Programme of a 50% reduction by 1995. The decline was driven overwhelmingly by a 77% reduction from urban point sources and a 76% reduction from industrial point sources. Diffuse source inputs were reduced by 59%. These changes are illustrated in Figures 2 and 3.

Photo: CEEP

In 1985 more than a third of all phosphorus input to the Rhine arose from urban pollution from Germany. The 81% decline in this source by 1996 is highly important in driving improvement in the river. Early investment in phosphorus removal was driven by a domestic political agenda (both to improve conditions in the Rhine and also for other water bodies). In later years the requirements of the EC 1991 urban waste water treatment Directive (see below) were also important. The 1998 deadline in this Directive suggests that improvements in point sources have continued beyond 1996.

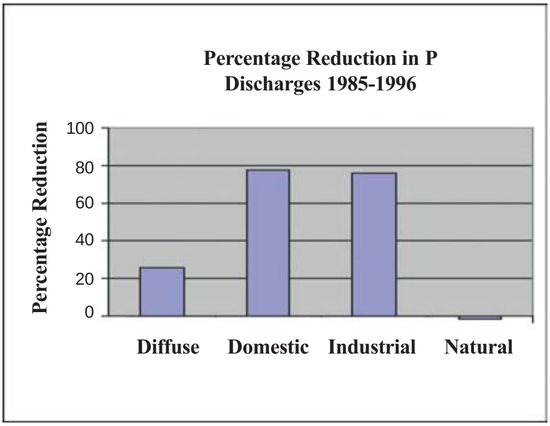
Nitrogen sources

In 1985 the contribution of point sources (284,000 t N/a) was slightly more than that from diffuse sources (249,000 t N/a) (see Table 2). By 1996 the diffuse source contribution had declined only slightly to 230,000 t N/a, while that from point sources was reduced to 162,000 t N/a. Overall this represents a reduction of 26%. This is only about half of the target of 50% for 1995 in the Rhine Action Programme. The largest decline derived from the industrial sector, which accounted for 15% of point source inputs in 1985, but only 5% in 1996 (or a 77% reduction in absolute emissions). This contrasts with a 27% reduction in discharges from sewage treatment works.


Photo: CEEP

The largest single point source is, as with phosphorus, urban pollution from Germany. While some improvement has been made, this has not been so striking as for phosphorus. The large quantities of diffuse nitrogen pollution also remain of concern. However, the EC nitrates Directive had yet to be fully implemented by 1996 and it is expected that some further nitrogen reduction will have occurred as this Directive was implemented in subsequent years.

Figures 2 and 3: Percentage reduction in phosphorus and nitrogen discharges to the Rhine by source between 1985 and 1996 (note the percentage increase in P discharges from natural sources).



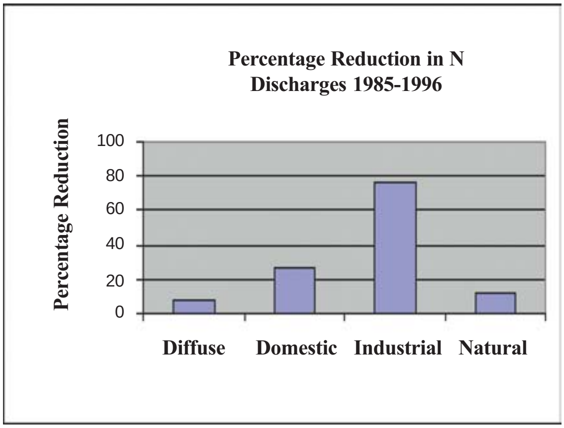


Table 1. Sources of total phosphorus in 1985 and 1996 to the Rhine. All values are in tonnes per year.

Country	Diffuse		Domestic point		Industrial point		Natural		Total	
	1985	1996	1985	1996	1985	1996	1985	1996	1985	1996
CH	448	449	2,300	900	150	35	98	138	2,996	1,522
D	8,987	6,452	25,970	4,925	3,370	590	625	605	38,952	12,572
F	2,190	1,527	3,520	830	1,280	410	108	108	7,098	2,875
NL	5,430	4,229	6,749	2,071	11,989	3,000	524	524	24,692	9,824
Total	17,055	12,657	38,539	8,726	16,789	4,035	1,355	1,375	73,738	26,793

Table 2. Sources of total nitrogen in 1985 and 1996 to the Rhine. All values are in tonnes per year.

Country	Diffuse		Domestic point		Industrial point		Natural		Total	
	1985	1996	1985	1996	1985	1996	1985	1996	1985	1996
CH	11,912	13,789	19,500	14,300	1,000	1,000	9,726	4,729	42,138	33,818
D	146,310	123,560	135,220	95,760	69,450	13,740	45,860	43,120	396,840	276,180
F	25,450	26,340	15,800	9,510	15,000	4,400	8,400	8,400	64,650	48,650
NL	64,847	66,149	22,780	21,377	5,221	2,160	3,794	3,794	96,642	93,480
Total	248,519	229,838	193,300	140,947	90,671	21,300	67,780	60,043	600,270	452,128

Waste water treatment in the Rhine states

Waste water treatment works have been important sources of both nitrogen and phosphorus to the Rhine. It is not possible in this space to detail the historical changes that have taken place in waste water treatment in each Rhine bordering state.

All states in the Rhine catchment area (except Switzerland and Lichtenstein) are required to implement the 1991 European Community Directive on urban waste water treatment (91/271/EEC). However, in Switzerland, in 1999, reports indicate that 73.8% of the total public waste water was treated to an advanced standard (usually nutrient removal).

The urban waste water treatment Directive, inter alia, established objectives for nutrient removal for discharges to waters that are eutrophic or that may become eutrophic. These objectives should have been met by the end of 1998. Member States had two options. They could either designate individual waters as sensitive, in which case waste water discharged from sewage treatment works serving a population equivalent of more than 10,000 would require either 80% phosphorus removal and/or 70% nitrogen removal (depending on the potential impact) or a combined phosphorus and nitrogen removal of 75%. Alternatively, Member States could designate their entire territories as sensitive and meet a 75% reduction for both parameters for all waste water treatment plants.

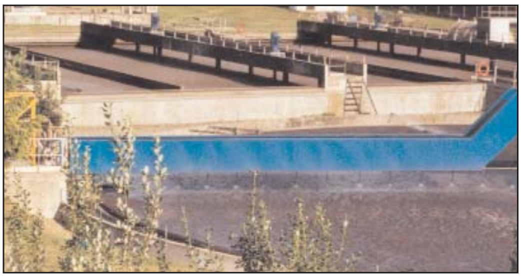


Photo: CEEP

In November 2001 the European Commission published a short report detailing compliance with these requirements (COM(2001)685). For the relevant Rhine bordering states the main findings of the European Commission and other relevant sources were:

Belgium: a very small part with a low population density of the Wallonia region is in the Rhine catchment. The European Commission is critical of the Wallonia government for restricted designation of sensitive areas and only in 2000 did the Wallonia regional government state that it would consider the whole of its territory as sensitive. Thus, to date, many of the treatment plants in this region lack adequate nutrient removal.

France: Although France is criticised by the European Commission for restricted designation of sensitive areas, the entire Rhine catchment in France is nonetheless designated. For the whole of France, at the end of 1998, 130 of 158 agglomerations in sensitive areas did not meet the requirements for nutrient removal. The most recent published material addressing France refers to 1996, when 58% of phosphorus was removed in the Rhin-Meuse catchment and only 30 of the 62 agglomerations above 10,000 population equivalent removed 70% or more of the nitrogen input.

Germany: the entire territory of the Rhine catchment part of Germany has been designated as sensitive. Much of this territory has extensive phosphorus removal, but additional treatment in many waste water treatment works is required to remove nitrogen.

Luxembourg: the entire territory has been designated as sensitive. While treatment removes more than 75% of phosphorus prior to discharge, additional investment will be required before the requirement for 75% removal of nitrogen has been met.

The Netherlands: the entire territory has been designated as sensitive. By the end of 1998 the Dutch reported that the requirement for 75% removal of phosphorus had been met, but that nitrogen removal at that date was only 60%. It is expected that full conformity with the Directive will be achieved by 2005.

The efforts made on phosphorus removal in Germany, Luxembourg and the Netherlands have been a major contributor to the significant improvements in water quality in the Rhine (see below). However, the focus of these countries has been on the potential eutrophicating effects of phosphorus in freshwaters, rather than the wider nutrient context. This is now changing. The European Commission is of the view that the North Sea (or at least parts of it) should be considered as sensitive. This means that significant controls on nitrogen discharges will be required for relevant waste water treatment works in the Rhine catchment. This will, therefore, require additional investment in some facilities in Germany, Luxembourg and the Netherlands.

The situation in Belgium and France has been less satisfactory. In Wallonia restricted designation has led to inadequate investment in waste water treatment. In France, despite designation of the territory of the Rhin-Meuse Water Agency the necessary treatment facilities have only been partially installed. In both cases further investment is promised and this, it is now clear, must include treatment to remove both nitrogen and phosphorus.

In conclusion, therefore, although there has been significant reduction in phosphorus discharges from waste water treatment works, reductions of nitrogen discharges have been limited. However, it is expected that some additional reduction in phosphorus discharges to the Rhine catchment from waste water treatment works will continue into the near future and that significant reductions in nitrogen discharges should be expected.

Nutrient concentrations in the Rhine

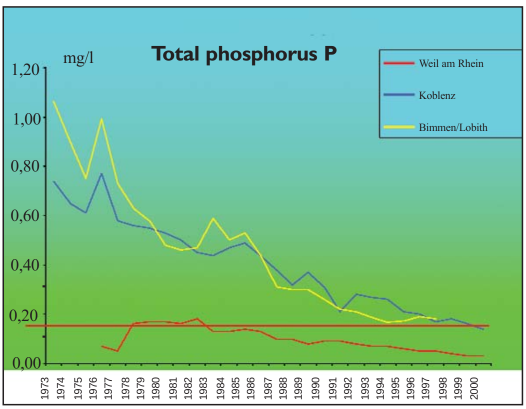
Water quality has been monitored for many years at different locations along the length of the Rhine. The accompanying figures present data from three locations (located progressively upstream):

- Bimmen/Lobith (1971-2000)
- Koblenz (1971-2000)
- Weil am Rhein (1977-2000)

Phosphorus

Phosphorus concentrations have shown a dramatic decline at all three monitoring locations (Figure 4), so that the target concentration has been met along much of the river. This trend has occurred since the mid-1970s in the mid/lower monitoring stations and since the early 1980s in the upper monitoring station (where phosphorus levels were already nearly at the target concentration). Phosphorus concentrations in the river have responded relatively well to changes in inputs and the significant decline in discharges (see above) is reflected in the improved river water quality.

Figure 4. Phosphorus concentrations at three locations along the Rhine 1971-2000.

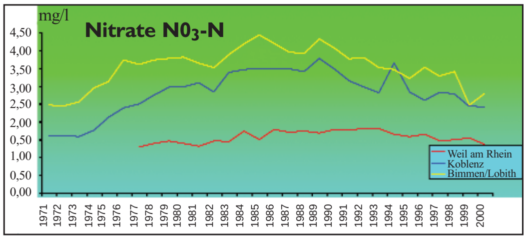


Nitrogen (nitrate)

The data at each location show similar trends but these are very different to the trends for phosphorus (Figure 5). Concentrations are higher at sampling points further downstearn, so that currently concentrations at Weil am Rhein are less than half those at Bimmen/Lobith. At all locations concentrations rose in the 1970s, reaching peaks in the mid to late 1980s or even early 1990s. At Koblenz concentrations of nitrate more than doubled, but smaller increases were found at the other two sites. In the late 1990s concentrations have begun to decline, but at no location have concentrations returned to those shown when monitoring started.

The decline in nitrate concentrations is certainly less marked than the relative decline in discharges (see above). Part of the reason for this may be the large contribution of diffuse sources, especially those entering via groundwater. There is a significant time lag (of many years) between nitrogen entering groundwater and its influence on the river. Thus it may be some time before improvements in river water quality fully reflect changes in pollution sources.

Figure 5. Nitrate concentrations at three locations along the Rhine 1971-2000.



Rhine 2020 – The Rhine Sustainable Development Programme

Following the completion of the Rhine Action Programme in 2000, Ministers agreed in 2001 to a new programme to run to 2020. The programme builds on the successes of the earlier initiatives and takes forward action on ecosystem improvement, flood prevention and protection, water quality and groundwater protection. In each category a wide range of detailed targets has been established. These include a commitment to achieve compliance with target values of all substances in the Rhine, including phosphorus (for nitrogen there is no target value except the reduction required under the North Sea Conference) and to meet strict ecosystem objectives. This will require full implementation of measures on domestic and industrial pollution sources as well, but will particularly target diffuse pollution sources, and more environmentally sensitive farming practices.

The restoration of the ecosystem will be linked to flood prevention and will include restoring ecological continuity, restoration and reforestation of alluvial areas (1200km^2) and reconnection of old branches and tresses of the river.

The Rhine Commission is also increasing its co-operation with non-governmental organisations (NGOs). This developed from a conference organised by the Commission called 'Living with the Rhine', which addressed all relevant issues and aimed to assist future policy development. National and international NGOs participated. In the framework of the new Rhine convention the NGOs have been integrated at the level of the plenary meetings and with the working groups.

Future management of the Rhine

1998 the 12th Conference of Rhine Ministers agreed the New Rhine Convention. The experience of the previous fifty years has underlined the importance of an integrated approach to the management of the river. The new convention has addressed and integrated all of the elements necessary for the future sustainable development of the Rhine. It has recognised the need for effective information exchange and co-operation with NGOs and for consensus on objectives and means. This principle not only means that there is inter-governmental agreement, but that citizens and communities are brought within the decision making process.

The history of the Rhine Commission's work also demonstrates the need for flexibility in implementation of programmes. Experience has shown that detailed prescriptive programmes take time to develop and tend to hinder implementation in some countries or regions. This flexible approach will also be taken in relation to polluters such as industry. Decisions of technical issues, investments, etc, can be better undertaken by these stakeholders rather than at the inter-governmental level.

The work of the Rhine Commission (and future developments) has become increasingly open and transparent. The reasons for objectives, actions, etc, must be clear and understood by the public. The Commission's information strategy will increasingly take advantage of the opportunities afforded by information technologies.

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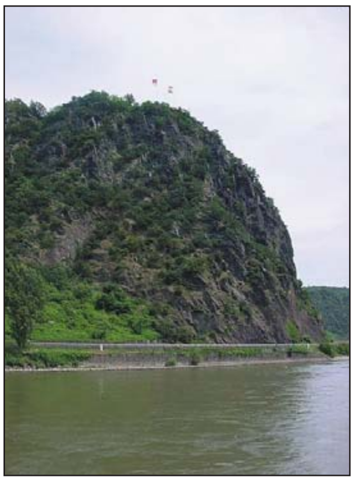
The EU water framework Directive

The water framework Directive (2000/60/EC) adopted by the European Union in 2000 requires Member States to take a river basin approach to qualitative and quantitative aspects of water management. Some aspects of the Directive owe much to the experience of international co-operation gained from the fifty years of the operation of the Rhine Commission. However, the Directive does impose additional obligations on the EU Member States that border the Rhine. In particular co-operation is being extended to the entire Rhine catchment, including eight states and the European Commission (six being EU Member States – Austria, Belgium, France, Germany, Luxembourg, the Netherlands - the other two being Lichtenstein and Switzerland) A steering group and preparation-group have been set up including both EU Member States and Switzerland and Lichtenstein. These groups will co-ordinate drafting of an international management plan for the Rhine river basin and are given practical support by the office of the International Rhine Commission within the available capacity. It will also need to address other implications of the Directive, such as setting ecological quality objectives and how its seven year plan review period links to action plans developed under the Rhine Commission. Ultimately, the framework Directive may lead to Member States taking further action to reduce nutrient inputs to water bodies, especially from those sources which have had less control until now, such as diffuse agricultural pollution.



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Conclusions

The fifty year history of the Rhine Commission is a success story. While international agreement on environmental improvement was slow to be reached between the Rhine bordering states, increasing public concern and political reaction to the Sandoz accident did result in a wide ranging series of policy measures. Water quality has improved for many parameters, the physical structure of the river has been upgraded and salmon have returned.

The general success story is repeated when one considers phosphorus discharges. Total discharges have fallen dramatically and water quality monitoring indicates that the target value for a sustainable ecosystem has been met along much of the river. This has largely been due to extensive investment in phosphorus removal in domestic and industrial waste water treatment works. Further investment has (or will) take place in selected locations due to pressure to implement EU legislation and, therefore, it is likely that further water quality improvements will be seen. Thus, when viewed as a whole, phosphorus is no longer a parameter of major concern in the Rhine.

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This success has not, however, been repeated for nitrogen. While there has been an important reduction in discharges since 1985, those that remain are highly significant, particularly given that they are carried by the Rhine into the North Sea coastal area where nitrogen loads are considered to be the key factor for eutrophication. The role of diffuse nitrogen pollution is of considerable concern. Minor improvement has been seen in nitrate levels in the Rhine water column, but concentrations are well in excess of the reduction targets. There is pressure at an EU level to invest in additional nitrogen removal on waste water treatment works and to reduce nitrogen applications in agriculture. It remains to be seen, however, what effect (and when) this will have on the water quality of the river and on nitrogen loads carried to the North Sea.

The future management of the Rhine will be more comprehensive in nature than anything previously. The new Rhine 2020 Program for sustainable development has detailed targets for many different management issues in the river and the implementation of the EU water framework Directive will result in a fully integrated management plan and a wider geographic consideration of the full catchment. It is not known what implications this might have for nutrient management. However, it is likely that attention will focus on any remaining significant point sources and on innovative measures to tackle diffuse sources.

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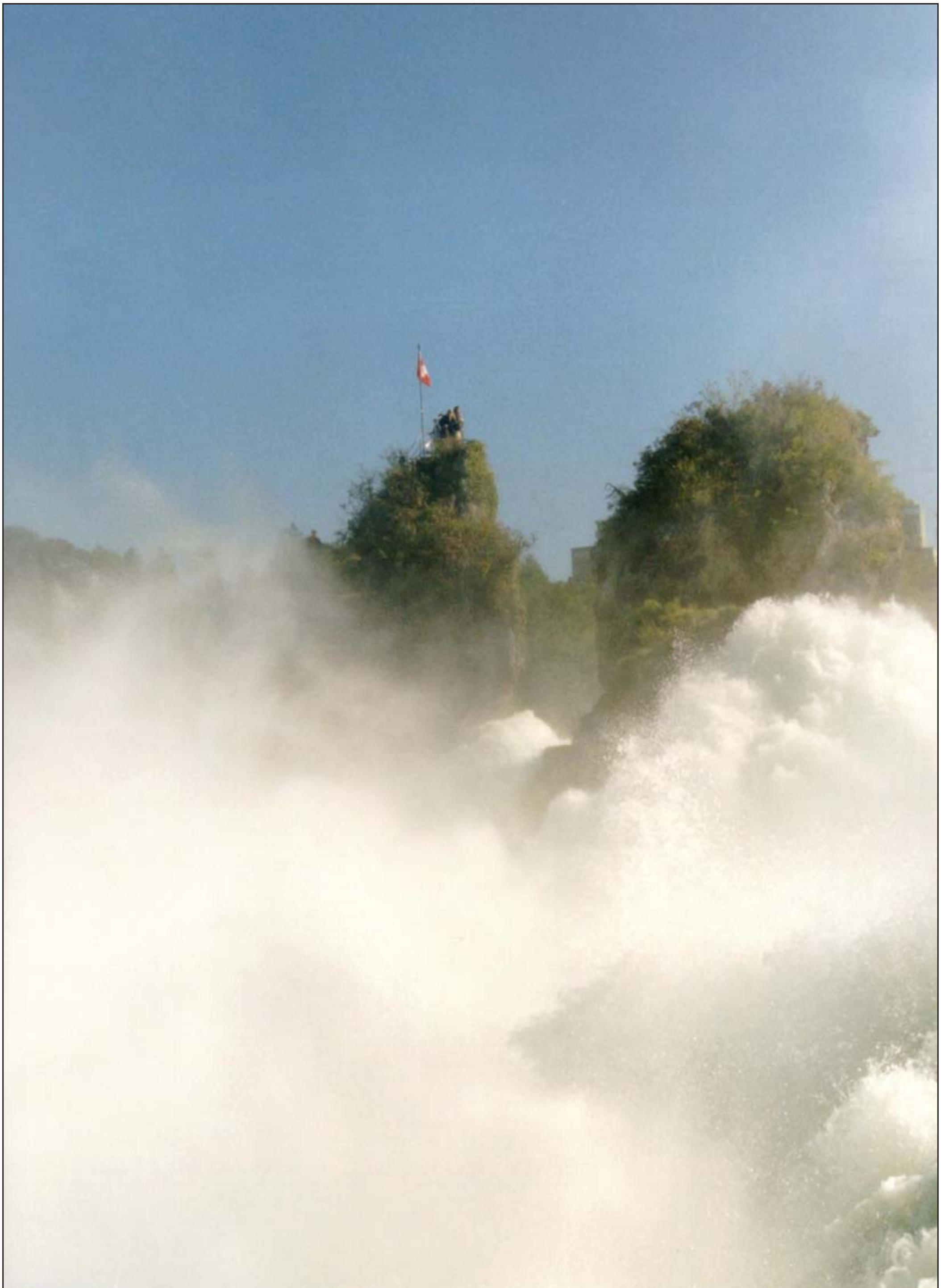

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The SCOPE Newsletter is open to input from its readers and we welcome all comments or information. Contributions from reader are invited on all subjects concerning phosphates, detergents, sewage treatment and the environment. You are invited to submit scientific papers for review.

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