# Plate 7.6 Changes in Selected Chemical Parameters, 1976–2000

## Introduction

In recent years, the state of rivers and lakes in Switzerland has continued to improve, thanks to the expansion of sewage treatment and the ban on phosphates in washing powders. Water quality can be described as good to excellent in rivers and streams whose catchments are mainly in Alpine regions and larger rivers where the pollutants are considerably diluted by the pure volume of water. In contrast, a significant level of pollution can still be observed in smaller rivers and streams in the densely populated Central Lowlands. This development is illustrated in the present plate, which presents a time series for the period 1976 to 2000. The results of water analyses carried out by cantonal and federal authorities have been used to illustrate selected chemical parameters in rivers and lakes. The measurement networks and the sampling methods are described in plate 7.1[2].

## The chemical parameters

Here, three main parameters are considered most indicative of man-made pollution of rivers and lakes:

- Orthophosphates are a component of phosphorus that has a direct effect on plant life. The lowest possible concentration of orthophosphates is desirable, especially in lake tributaries, if eutrophication of lakes is to be avoided. Both household sewage and agriculture are sources of orthophosphates.
- Ammonium is a particular problem since in a warm environment with a pH of over 9, it is converted into ammonia, which is highly poisonous for fish. Ammonium can be found especially downstream of sewage inflow.
- Nitrates are not toxic in the low concentrations that normally occur, but this parameter is a good indicator of pollution from agriculture and treated urban sewage.

In this connection it should be emphasised that these three parameters give only a partial indication of the condition of rivers and lakes, namely one aspect of the balance of nutrients. An assessment based on these parameters is therefore far from sufficient to draw a global conclusion regarding surface waters.

## Measuring sites

Concepts and programmes of water analysis in cantonal agencies are based on current problems and often determined by financial resources. Long-term studies imply more work owing to the larger number of samples taken. The condition of rivers and lakes can also be assessed in shorter studies, in particular where pollution levels are low. The map shows only those measuring sites and/or time periods where the data meet certain minimum requirements (see below). The condition of lakes or rivers for which no results are indicated is therefore not necessarily unknown. In the case of the extensively farmed and thinly populated Alpine catchments in particular, for which the map provides relatively little information, the level of pollution is low. At this point, it should also be mentioned that, for reasons of legibility, only around 40 % of the measuring sites for which data are available are indicated on the map.

## Presentation of the results

Five categories in the so-called modular stepwise procedure [1,3] were used to assess the condition of rivers and lakes. In plate 7.2 the mean values for 1987–1989 were divided into only four categories. This means that the graduated colours used in plates 7.2 and 7.6 cannot be directly compared; the same colour does not correspond to the same category of concentration. In plate 7.6, lakes in particular have been classified according to more stringent criteria.

The data were assessed for 5-year periods; if the level of pollution rose, the colour changed from blue via green, yellow and orange, to red. As far as ammonium and nitrates are concerned, concentrations indicated in blue and green were below the requirements stipulated in the Water Protection Ordinance. No such requirement exists with regard to orthophosphates.

By comparing a total of five 5-year periods, developments in the condition of rivers and lakes can be followed for a total of 25 years.

The presentation of the values obtained indicates the heterogeneous nature of the data available for the individual 5-year periods. The results have been classified into four categories:

- solid square with bold borders: cumulative samples taken for at least 4 years of a 5-year period (continual measurement) or over 80 random samples taken during the period indicated;
- half-solid square with bold borders: cumulative samples taken for 1 to 3 years, or more than 24 random samples taken per year;
- solid square with normal borders: at least 4 random samples taken per year for 4 years per period;
- half-solid square with normal borders: at least 12 random samples taken over 1 to 3 years during the 5-year period, and at least 4 random samples taken per year.

Where the distance between two sampling points on the same river was very short, it was often not possible to show both results on our map. Furthermore, in a few cases where no differences were observed in the evaluation categories for overlapping or subsequent years, the two sites are indicated using one diagram, and were assigned the number of the more recent measuring site. This numbering method was also used for NADUF measuring stations when they had to be shifted for technical reasons.

## The state of rivers

As part of the Long-Term Surveillance of Swiss Rivers (NADUF) [2,4] cumulative samples are taken over a period of two weeks and analysed. Some of the measuring stations can provide values for the entire period since the mid-1970s. The parameters presented here indicate that in some respects the state of rivers and lakes has changed dramatically over the past 25 years; this is particularly true for phosphate content, which has declined considerably at many locations, thanks to the almost 100 % collection and treatment of urban sewage and the ban on phosphates in washing powders, which came into force in 1986. Today a significant proportion of the phosphorus found in surface waters in Switzerland is of agricultural origin, although there are recognisable trends towards more environmentally friendly approaches among farmers. A particular problem is the concentration of phosphorus in the soil in the Central Lowlands. Since phosphorus does not accumulate permanently in the soil, it will be a contributing factor in the eutrophication process in the medium to long term, even if further measures are taken in agriculture. The map and the charts indicate that both concentrations and fluctuations in the levels of phosphorus in rivers downstream from lakes are decreasing. As the level of phosphorus has fallen, the biomass and consequently metabolism in these lakes have also decreased.

After a period of increase that peaked at the end of the 1980s, nitrate content fell again in most places over the following 10 years. This is the result of a shift towards more environmentally friendly approaches among farmers, as mentioned above, as well as a drop in the emission of $NO_x$ achieved by introducing catalytic converters for petrol engines.

In the 1970s and 1980s high levels of ammonium posed a problem in small to medium-sized receiving waters that could not cope with the volume of sewage. It is true, however, that concentrations of ammonium are far lower only a few hundred metres below a sewage inflow thanks to the fact that the current breaks down ammonium from nitrite to nitrate, a process that is particularly marked when the water is warm. The situation has been considerably improved through modernisation of sewage treatment plants and better nitrification.

## The state of lakes

The principal information provided on the map is mean concentrations of total phosphorus. Oxygen levels at various depths are indicated in a diagram on the reverse side.

The term total phosphorus includes all dissolved or particulate phosphorus compounds of organic or inorganic origin. Although particulate mineral phosphorus compounds that cannot be taken up direct by algae as nutrients are transported by rivers as suspended sediment load, they are quickly deposited in lakes, owing to the short sedimentation time. For this reason, total phosphorus content in lake water consists mostly of dissolved and particulate organic compounds. It is a good indication of the man-made pollution of a lake and at the same time one of the most important factors influencing bio-production. The latter affects the oxygen content of deeper water through the oxygen demand for the mineralisation of biomass. A high level of nutrients gives rise to a lack of oxygen in lakes (cf. chart entitled Sauerstoffverhältnisse in grösseren Seen – Oxygen content in larger lakes). The information shown here concerning oxygen content of Swiss lakes at different levels represents the situation at the end of the summer. At this time of the year, a large proportion of the oxygen that entered the lakes during the spring overturn has been used up. The diagram shows the most unfavourable situation that arose during the 2-year period. In the case of lakes that show strong fluctuations in oxygen content in deep water from one year to the next, a positive trend over a number of years or even decades is not always apparent in such presentations, particularly when the 2-year period analysed coincides with a number of unfavourable years.

Phosphorous leaching from a catchment and its subsequent transport into a lake both depend on land-use, population density, and the degree of water treatment. By analogy with the categories used for rivers, phosphorus concentrations in lakes have also been classified into five categories.

## Trends since 2000

In some lakes in the Central Lowlands, there has been a marked drop in phosphorus content since 2000. For example, the level of phosphorus in Lake Sempach in spring 2004 was already below 30 µg/l, the target value set by the canton of Lucerne some years ago. Although the phosphorus content of Lake Baldegg was around 50 % higher in the same period, it has been reduced by 90 % over the past 30 years.

In 2001 and 2002 there was a rise in concentrations of total phosphorus in Swiss rivers (cf. chart entitled Zeitreihen ausgewählter Parameter – Time series of selected parameters). In comparison with the year 2000, there was an increase of 1000 tonnes of total phosphorus in the River Rhine in Basle. In 2003 concentrations fell again, owing to the fact that inflow loads were smaller following the exceptionally dry summer.

## References


[1] **Bundesamt für Umwelt, Wald und Landschaft (1998):** Methoden zur Untersuchung und Beurteilung der Fliessgewässer. Modul-Stufen-Konzept, Vollzug Umwelt, Mitteilungen zum Gewässerschutz Nr. 26, Bern.

[2] **Bundesamt für Umwelt, Wald und Landschaft (2000):** NADUF. Messresultate 1977–1998, Schriftenreihe Umwelt 319, Bern.

[3] **Bundesamt für Umwelt, Wald und Landschaft (in Vorbereitung):** Methoden zur Untersuchung und Beurteilung der Fliessgewässer. Modul Chemisch-Physikalische Erhebungen, Vollzug Umwelt, Mitteilungen zum Gewässerschutz, Bern.
Internet: www.umwelt-schweiz.ch/wasser (Stand: 10.2004).

[4] **Nationale Daueruntersuchung der schweizerischen Fliessgewässer:**
www.naduf.ch (Stand 26.03.2003).