Plate 7.2 Average Concentration of Chemical Parameters in Surface Waters

Introduction

The depiction of the average concentrations of selected chemical parameters in rivers and lakes is based on results of water quality studies carried out by the cantonal and federal institutions in the years 1987 to 1989. The measurement networks, as well as the techniques and frequency of sampling, are described in detail on map 7.1.

Rivers

In order to provide a representative view on the state of surface waters, minimum requirements on the data collected had to be set: sites recording fewer than six measurements per year were considered in exceptional cases only (the cantons of Neuchâtel, St. Gall and Thurgau). Due to differences existing in the terms of measurement frequency and the sample-taking techniques (random or cumulative), measurement sites are comparable only on the basis of averaged values. It is for this reason that average concentrations for the four selected parameters were calculated for the period 1987–1989. The division into categories was done according to the recommendations for the study of Swiss surface waters [1], taking into account the value distribution in the 1987–1989 time span. In Swiss rivers, the extent of variation in the concentrations observed is considerably smaller than in the rivers of adjacent countries. It is for this reason that this classification and the allocation of colours to the categories cannot be compared with the customary international ones.

Due to the increase in sewage treatment plants and the expansion of the sewage system, the water quality has continually improved during the last years. It can be described as good to very good both for rivers whose catchments lie mainly in the alpine region, and for larger rivers in which the substances introduced are diluted by the large quantities of water. It is in the smaller rivers of the densely populated midland area, however, that excess pollution levels still occur.

Figure 1 indicates the temporal variability of the water quality in the years 1977 to 1989, considering the results obtained at six NADUF stations. Due to measures taken to improve water quality, the concentrations of parameters such as total phosphorus and orthophosphate, influenced mainly by sewage, have considerably decreased in the observation period.

A circular diagram is used for the cartographic representation of the four chemical parameters selected. Each parameter is assigned to one sector. If no measurements are available for a parameter, the corresponding sector has not been coloured. This, for example, concerns ammonium which does not exist at measurement sites in the NADUF network because it cannot be determined in the bi-weekly cumulative sampling at a comparable standard of quality. Each circular diagram is assigned to a number matching the relevant measurement site number in map 7.1. In fourteen cases, measurement sites not depicted on the map 7.1 were considered as well; they are summed up in the table on the map page. By the increased size of their sectors, the NADUF stations are distinguishable from the cantonal measurement sites. To allow a clear depiction, certain measurement sites had to be left out.

For the map-making, parameters were selected which serve to indicate the impact of civilization on a river:

- Orthophosphate represents the phosphorus components having a direct physiolgical effect on plants. The goal is to achieve the lowest possible concentration of orthophosphate, particularly at lake inflows. During the last decade the phosphate content has decreased by more than 50 % at most sites, thanks not least to the 1986 ban on phosphates in detergents.
- Ammonium is considered a problematic substance primarily because at high temperatures and alkaline range (high pH values) it forms ammonia, a substance highly poisonous to fish. Additionally, an ammonium content too high for a water body will impair the domestic water supply, either due to oxygen extraction following infiltration into a groundwater body, or to

problems arising during the chlorination of water containing ammonium. Because of the decomposition in flowing water, the ammonium content in small rivers decreases considerably within a few hundred meters below the point of sewage inflow.

- In spite of the increase in nitrate, attributed to the growing use of artificial fertilizers in the past twenty years, no negative effects have been observed in the surface waters so far.
- The measurement of the dissolved organic carbon (DOC) includes all dissolved organic material. As a result of the inflow of treated or untreated sewage, organic material containing both substances that are to be decomposed and substances of chemical-synthetic origin that are not to be easily decomposed is found in rivers. When evaluating the measured values, the DOC portion of natural origin, containing humic acid or derivative products of algae, has also to be considered. Because of this, increased DOC concentrations appear in the discharge from moors and eutrophic lakes. The diversity and incidence of the various species found in the aquatic environment are influenced by the composition and concentrations of the organic substances taken as sum parameter of DOC.

Lakes

The mean concentrations of total phosphorus are a prominent feature on this map of the lakes. In figure 2, the oxygen conditions in the lakes are observed.

The term total phosphorus includes all dissolved and particle-bound phosphorus compounds of organic and inorganic origin. Particulate mineral phosphorus compounds which cannot be absorbed as a nutrient by the plants (algae) are in fact transported as suspended sediment in the rivers; in lakes, however, they soon settle down due to the short sedimentation time. Therefore the total phosphorus content in the lake water comprises usually dissolved and particulate organic compounds only. It is a criterion of anthropogenic impact on the lake and the most important regulating factor for bioproduction at the same time, influencing in its turn the oxygen content in the deeper part of the lake by decaying algae to be decomposed. Therefore a nutrient excess in the lakes will cause an oxygen deficiency (cf. fig. 2). Very little phosphorus is deposited permanently in the sediments under such anaerobic conditions.

The extent to which phosphorus is flushed out of a catchment and transported into a lake depends on the extent of agriculture, on population density and on the condition of the sewage system. Alpine catchments tend to be sparsely populated and have low-intensity farming; their discharges hardly affect the lower lakes. The rather high degree of pollution of the smaller lakes in the midland region, on the other hand, results mainly from the intensive practice of animal husbandry in these catchments.

In Switzerland, measurement data exist for most of the larger natural lakes (cf. map 7.1). On the contrary, only a few are available for reservoir lakes.

On the basis of the average concentrations of total phosphorus, the lakes were divided into four categories: the deciding factor was the total phosphorus content in untreated water during the overturn of lake water in spring. For small lakes with intense phosphorus cycling and a high re-mobilization of phosphorus, the state in autumn was also taken into account.

There are very few lakes with a phosphorus content in the range of 15 to 30 µg P/l, or of 60 to 100 µg P/l. Because of bioproduction which influences the nutritive content as well as the oxygen and phosphorus distribution in the lake and sediments, various more or less stable lake conditions are possible.

The present depiction applies only to a very brief period of time (1988–1989). The phosphorus concentrations observed frequently do not correspond to the current pollution levels of the inflowing streams. These pollution levels have considerably decreased in the last few years. Therefore, a further improvement in the condition of most lakes is expected in the years to come. The decline in nutritive content in many lakes in recent years has already led to a clear improvement in the oxygen levels (fig. 2). In addition, active aeration measures are being employed at a small number of individual lakes.

References

[1] **Département fédéral de l’intérieur (1982):** Recommandations concernant l’analyse des eaux superficielles en Suisse (état 1982). Berne.