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GENERAL CONCLUSIONS

CAMPAIGN 2013

BY

THE SCIENTIFIC COUNCIL OF THE INTERNATIONAL COMMISSION

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LAKE GENEVA

1. PHYISCO-CHEMICAL TREND

A moderately cold winter and thus, partial homogenisation, leads to incomplete re-oxygenation of the deep layers and limited redistribution of nutrients to the surface layers. The average phosphorus concentration has been diminishing slowly.

The year 2013 was a moderately warm year compared to the chronic years of 1981-2012 where the annual average temperature was 10.3 °C.

Winter 2012-2013 was less severe than in 2011-2012 with a slightly windy winter, except in November. Therefore, it was characterised by partial homogenisation of the water column up to 120 m, which did not permit re-oxygenation of the deep layers or redistribution of nutrients throughout the water layer.

From March, declining nutrients found in the surface layers reflected the resumption of the spring phytoplankton activity. In late May, an increase of transparency clearly delineated a clear-water phase. Subsequently, the particulate organic matter peak clearly appeared at the end of the summer, corresponding to the resumption of photosynthesis.

Despite partial re-oxygenation of the water column in 2013, the release of phosphorus and ammonia nitrogen was relatively low due to the maintenance of dissolved oxygen in the consecutive, fully homogenised deep water in 2012.

This increase was partly due to the heavy rainfall in late 2012, which led to leaching of soils in the watershed and thus an increased input of nitrate nitrogen in Lake Geneva.

The total phosphorus stock in 2013 was slightly lower than in previous years with 1,696 tonnes and the average concentration was 19.7 $\mu gP \cdot L^{-1}$. The goal for 2020 is to reach a concentration of 10 to 15 $\mu g. L^{-1}$.

Finally, the chloride stock continued to increase and the annual average concentration appeared to be approaching an asymptotic value close to the average levels of contributions by the tributaries of Lake Geneva.

2. BIOLOGICAL TREND

Maintenance of the phytoplankton biomass. Inter-annual survey of filamentous algae blooms (*Mougeotia*) helped identify potential future blooms.

Overall, the phytoplankton biomass was low and similar to that of 2012, and phytoplankton composition continued to indicate re-oligotrophication of the water. However, the year 2013 was marked by a high-spring biomass with an annual maximum in late March / early April. Centric diatoms dominated the biomass at that time. Then, after clear-water phase in late May, the biomass divided by three until the end of the year. During the summer, these were indicator species of oligotrophic conditions that settled and dominated (Chrysophyceae).

Subsequently, autumnal communities settled, in particular Chrysophyceae and cyanobacteria. There was also a significant presence of a frequent diatom (*Achnanthidium catenatum*) in coastal benthic biofilms. Its presence may be related to heavy rainfall and river runoff that would have transported it to the pelagic zone.

The chlorophyll a concentration measured in the first 30 meters was slightly lower compared to the year 2012 and was typical of oligo-mesotrophic aquatic environments. However, the net primary annual production appeared to have increased compared to 2012.

Analysis of blooms occurring between 2000 and 2011 of a filamentous alga, *Mougeotia*, was conducted in 2013. This non-toxic alga creates problems for professional fishermen and is an unexpected response of re-oligotrophication in Lake Geneva. Indeed, the inter-annual dynamics of this alga is related to phosphorus levels, which must be between 5 and 15 ug / l (annual average in the 0-20 m layer) and seasonal dynamics are strongly influenced by stratification of the water. In addition, it prefers to live in low-light conditions (10 meters deep). These conditions, combined with a strong stratification of the water up to 10 meters, suggest that if phosphorus concentrations remain above 5 mg / L in the 0-20 m layer and if the weather and hydrological conditions described above occur again, blooms of filamentous algae could appear again in Lake Geneva in the coming years. Note that 2013, the *Mougeotia* bloom was not recorded.

Relative stability of an abundance of microcrustaceans, which remained the privileged prey of whitefish

The unusually cold and wet spring did not alter the abundance or the seasonal dynamics of zooplankton in 2013. The spring peak abundance reached levels comparable with those of previous years and marked a clear-water phase in late May, i.e. without noticeable delay compared to the years with warmer springs. Only *Daphnia* and Calanoids showed a second growth phase in summer and early autumn, which is not an exceptional phenomenon. Processes regulating the inter-annual dynamics of crustacean zooplankton seemed complex and a mix of both bottom-up (by the nutritional quality of phytoplankton) and top-down (predation by zooplanktivorousfish fish) controls on the food chain while direct climatic effects were less obvious.

Whitefish were still the largest tonnage catch in Lake Geneva. As in previous years, whitefish were high selective in the choice of their prey. They exerted a selective pressure on three taxa of cladocerans: *Bythotrephes*, *Leptodora* and *Daphnia*. The relative contribution of these three dominant taxa in the stomach contents changed during the year and was probably driven by the availability of prey in the area of whitefish distribution. In 2013, *Daphnia* contributed significantly from January to June and their contribution to the spring diet showed a rising trend over the period 2001-2013. In winter, the composition of the bolus was relatively similar to that observed in the last six years.

Abundance of the fish resource with a change in proportions of the target species caught.

The Lake Geneva fish population data and levies by fishermen had not been summarised since 1988. Statistical monitoring of fishing is always a prerequisite for inventory management and population information. Professional and recreational fishing was seen in the time series of catches since the early 1980s, corresponding to the entry into force of the Franco-Swiss agreement regulating fishing in Lake Geneva.

Fish resources appeared abundant. 2011 and 2012 were the most productive years for 30 years.

The decrease in phosphorus concentrations since the late 70s (impact on the oxygenation of deep waters and phytoplankton and zooplankton biomasses) and climate change resulted in a change in the proportions of different target species of fisheries, even if the fishing activity was still mainly whitefish and perch together accounting for over 90 % of the total catch. Catches of whitefish and pike increased significantly since the 1990s, while catches of perch remained stable. The statistics were complemented by a summary of knowledge on the evaluation of the effectiveness of restocking char and freshwater trout.

3. METALS AND MICROPOLLUTANTS IN WATER

Stable levels and relatively low compliance with the regulatory requirements for drinking water.

Levels of heavy metals were stable and low. They fully met the requirements for drinking water. The concentrations of total pesticides in the lake has stabilised since 2008 and ranged between 0.12 and 0.18 mg / L. Regarding metalaxyl (fungicide), after several years of growth, the contents finally declined, but often remained above 0.020 mg / L. Autumn samples helped highlight traces of atrazine in the lake bottom and the amount of this herbicide metabolites expressed as the parent compound appeared to be increasing since 2011; however, the individual concentrations of each pesticide remained below those set out in the legislation for drinking water (0.1 mcg / L per compound and 0.5 mg / L for all substances). For pharmaceuticals, two additional campaigns embellished with an enlarged pallet of 58 molecules comprising amongst others, psychotropics, failed to reveal residues other than those already measured in previous campaigns (anaesthetics, antiepileptics and muscle relaxants).

LAKE GENEVA WATERSHED AND THE DOWNSTREAM RHONE

1. SUMMARY OF CONTRIBUTIONS TO THE LAKE AND THE DOWNSTREAM RHONE BY RIVERS

Decreased phosphorus and the stability of nitrogen and chloride inputs

Analysis of nutrient flows of the main tributaries of the CIPEL territory showed some differences between the river watersheds, and sometimes quite large annual fluctuations related to the influence of weather conditions. However, observation of the results in the long term allowed the identification several trends. Inputs of total phosphorus by the main tributaries of Lake Geneva declined since 2008 and remained relatively stable. Inputs of total inorganic nitrogen have been relatively stable since 1980 and were due to the absence of de-nitrification in the bulk of the Lake Geneva basin WWTP and stable nitrogen fertilisation for nearly 20 years. The amounts of chloride, increasing since 1980, appeared to be relatively stable since 2010 by a decline in their rise.

For the downstream rivers of the Rhone basin, contributions in soluble reactive phosphorus were relatively stable in recent years. Those of total nitrogen and chloride were mainly related to rainfall, with the influence of the arrival of water from Lake Geneva for chlorides.

2. MICROPOLLUTANTS IN THE RHONE WATERS

Decreased pesticide levels, but increasing amounts of drug residues. Concentrations were still too high.

One hundred and thirteen pesticides, 25 pharmaceutical active ingredients and two corrosion inhibitors were analysed systematically in the Rhone water upstream of Lake Geneva throughout the year 2013. Three pesticides, amidosulfuron, linuron and Iodosulfuronmethyl, exceeded the Ordinance requirements on the protection of water of 0.1 mg/L. Of the 25 active pharmaceutical principles sought, 12 were found in the waters of the Rhone at levels lower than the years before 2012 with concentrations up to 1.46 mg/L for prilocaine.

In terms of annual flows, the total quantities of pesticides that passed through the Rhone in 2013 decreased compared to 512 kg to 678 kg in 2012, 731 kg in 2011 and 1010 kg in 2010. Quantities of drugs increased again with 761 kg compared to 425 kg in 2012, 677 kg in 2011 and 1,560 kg in 2010.

3. MODELING OF THE FLOW FROM MICROPOLLUTANTS RELEASED FROM WWTP DISCHARGES

A study to assess the degree of contamination of surface water (lakes and rivers) by micro discharges from domestic wastewater

CIPEL and FOEN wanted to assess in 2013, the degree of contamination of surface water (lakes and rivers) by micropollutants from the discharge of domestic waste water and evaluate the success of mitigation measures that could be taken at WWTP, such as the installation of a quaternary ozonation treatment or the dosage of powdered activated carbon.

Over the CIPEL territory, nearly 2.3 million people discharge daily micropollutants via the use of cosmetics, household products or drugs. These substances enter aquatic environments after passing through no less than 218 wastewater treatment plants (WWTP). For rivers, a calculation model was used to estimate the concentrations at low water at each point of wastewater discharge and compared them to ecotoxicological quality criteria to identify waterways particularly contaminated requiring priority remediation. The lake system was treated using the flows in the lake, which helped to predict the trends of loads accumulated in Lake Geneva. Finally, three scenarios to reduce the flow from WWTP micro-discharges, associated treatment costs, were used to illustrate the effect of different WWTP equipment strategies, both in terms of micropollutant discharge in waters and improving the quality of ecotoxicological streams. The results showed that the solution is complex and cannot be solved globally by equipping a certain number of WWTP. Instead, they suggested illustrating the particularly problematic cases that can serve as decisional support in Switzerland and France for control actions and reduce pollutants in surface waters.

4. WASTEWATER TREATMENT PLANT

Good performance of the purification of wastewater treatment plants (WWTP) in accordance with the regulations, but effort needed to achieve the objective of the 2011-2020 Action Plan. An initial assessment of contributions by micropollutants by the WWTP effluents was proposed.

WWTP performances were generally good across the Lake Geneva basin and better than the legal requirements with regards to total phosphorus and BOD5.

In 2013, 220 WWTP were in service in the CIPEL territory. More specifically in the watershed of Lake Geneva, 144 WWTP (representing 99 % of the capacity of the plants of Lake Geneva) measured total phosphorus, which represented for aquatic environments 112 tonnes, including 79 rejected after treatment and 33 tonnes discharged on input or during processing. The mean purification yield for total phosphorus is only slightly lower than in 2012, about 90 %. As in 2012, high rainfall in 2013, however, led to larger spills, which are hard to quantify because of the flawed equipment systems for measuring flow outfalls (bypass; sewer overflows and spillways on networks).

Furthermore, the effluent from 43 domestic plants in the territory was monitored for 1 to 130 micropollutants, one to four times per year in 2011, 2012 or 2013. An assessment was proposed for seven substances used by households in possible connected industries and in products used in agriculture and for the maintenance of green spaces or rendering. Considered plants varied by substance and represented, in terms of raw organic load, 64 % to 82 % of total flows joining the territory’s plants. The contributions varied according to the substance from 13 to 751 kg / year. Although based on relatively few data, and its accuracy and robustness were not comparable to those reports made for large volumes, phosphorus or BOD5, this report is the first of its kind across the CIPEL territory. It helps to advance the study of the "micropollution" problem, which was the priority of the 2011-2020 Action Plan.

5. QUALITY ASSURANCE OF CHEMICAL MEASUREMENTS

Good quality results in inter-laboratory trials for major elements and pesticides.

In 2013, two inter-laboratory trials on major nutrient analysis (nitrogen, phosphorus, organic carbon, and major ions), plant protection products (pesticides), and various organic micropollutants of domestic origin on natural or wastewater matrices were organised by CIPEL.

Statistical analysis showed that all tests were considered good to very good with a dispersion of results in agreement with the expected values for each parameter and the level of concentration of the test (sample preparation, analytical techniques, etc.). The number of suspect results or outliers was usually between one and four of 20 participants for the major elements. For organic micropollutants, the number was between 0 and 2, and for 15 participants. Note, however, that these values varied slightly according to the parameter, the matrix and the level of concentration of the trial.