GENERAL CONCLUSIONS

CAMPAIGN 2015

BY

THE SCIENTIFIC COUNCIL OF THE INTERNATIONAL COMMISSION

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LAKE GENEVA

1. PHYISCO-CHEMICAL TREND

A relatively mild winter and so a partial winter mixing only allowing incomplete re-oxygenation of the deep layers and limited redistribution of nutrients in superficial layers. The average phosphorus concentration is continuing its slow downward tendency.

For the year 2015, the climate may be considered to have been warm and sunny with a slight breeze on the banks of Lake Geneva, showing a rainfall deficit of 20% by comparison with the 1981-2010 average. The summer was very hot and dry.

Winter 2015 gave rise to partial mixing of the water column down to 140 m reducing the re-oxygenation of the deep layers of Lake Geneva and the distribution of nutrients in the whole of the water column. The release of phosphorus from the sediments as also the reduction of nitrate nitrogen to ammoniac nitrogen at the bottom of the lake was not very significant for the end of 2015, nor for 2014.

The early establishment of thermal stratification at the beginning of March induced an advanced re-growth of phytoplankton activity and led to the diminution of nutrients at the same time as an increase in certain organic matter. This year has been distinguished by the presence of significant biomasses due to the proliferation of a non-toxic, filamentous algae (*Mougeotia gracillima*). For this reason, water transparency was not good during the whole of the spring and it has not been possible to show any period where the waters were clear.

In 2015, the average annual concentration of nitrate nitrogen was 574 $\mu gN.L^{-1}$, which represents a similarly large quantity to 2014, of 49,880 tonnes (expressed in nitrogen), it has remained relatively stable since the 1980s.

The average concentration of total phosphorus seems to be continuing its downward tendency, with an average annual value of 19.0 $\mu gP.L^{-1}$, (19.7 and 20.5 $\mu gP.L^{-1}$ in 2013 and 2014 respectively). The average quantity of total phosphorus is going down, with 1,634 tonnes of P.

Finally, the quantity of chlorine in Lake Geneva continues to increase and reached 894,400 tonnes in 2015. The average annual concentration, which, is now more than 10 $mgCl^{-}.L^{-1}$, tends more and more towards average concentrations of the intake from the tributaries of Lake Geneva.

2. BIOLOGICAL TREND

In spite of the relatively low concentrations of phosphorus, there is an increased phytoplankton biomass associated with an atypical spring bloom. The chlorophyll biomass and primary production was comparable to those observed since 2008 and consistent with the mesotrophic status of the lake.

The year 2015 is distinguished by a huge, early development of the filamentous algae *Mougeotia gracillima* with maximum biomasses at the end of June. The precocity of its development is associated with the fairly mild beginning of the year and high temperatures in the month of June. This algae develops at the interface between the epilimnion and the metalimnion in the zone at a depth of 15 m.

From the month of July, the algal biomass of phytoplankton and of *M. gracillima* would diminish gradually. The year-to-year dynamics of the phytoplankton shows that the average annual biomasses for 2014 and 2015 are distinctly higher than those of preceding years and exceed the target of 1000 $\mu g/l$ (average annual biomass) set by the CIPEL for Lake Geneva. The proliferation of *Mougeotia* diminishes the trophic status of the lake according to the Brettum index and classifies it as in a mediocre state according to European criteria.

Its atypical dynamics made 2015 stand out, distinguished by the absence of a phase of clear water. Water transparency was not good and there were high chlorophyll biomasses all through the spring in conjunction with the early appearance of *Mougeotia.*

The average values of chlorophyll biomass and of primary production observed in 2015 nevertheless remain comparable to previous years and are consistent with the mesotrophic status of Lake Geneva. The year 2015 was the hottest ever recorded on a global scale. It would, therefore, be possible to connect this atypical dynamic with the exceptional thermal conditions and very early establishment of a distinct stratification of the water.

The cladocera microcrustaceans remain the preferred prey of whitefish.

The exceptional abundance of the filamentous algae, *Mougeotia gracillima*, from April to July in the water column, severely limited the adequacy of the zooplankton count. Consequently, in the absence of density data for this period, the zooplankton dynamic cannot form the subject of an adequate analysis in 2015. Neither can it be compared with those of preceding years.

Fishing for whitefish still represents the greatest tonnage caught in Lake Geneva. As in preceding years, whitefish shows a strong selectivity in its choice of prey. They have the effect of exerting a selective pressure on three taxa of *Cladocera: Bythotrephes, Leptodora* and *Daphnias*. Their contribution to the alimentary bolus in whitefish varies according to the seasons and a relatively similar pattern to that observed in previous years. At all events, in winter and autumn 2015, the *Byotrephes* were relatively more abundant than throughout previous years. Summer 2015 appears to stand out due to the strong contribution of *Daphnias* and autumn by the lowest contribution of *Leptodora.*

Deep zoobenthos of superior quality, except at very great depths

The zoobenthos are collected in three different depth zones (sublittoral – 22 m, average depth – 150 m and maximum – 309 m) in order to monitor development of the structure of benthic communities. The abundance of oligochaete worms is similar in sublittoral zones and in zones of average depth, but three times less at 309 m. The larvae of chironomid insects colonise the bottom down to 150 m. The different quality indices for sediments show an average metabolic potential of the sediments to assimilate and recycle the nutritive constituents in the central plain (309 m) with an absence of species sensitive to pollution and an increase in the medium depth zone. Comparison of the results for the periods 2005, 2006, 2010 and the year 2015 shows that at medium depth, sensitive species of oligochaetes were present in 85% of samples in 2015 (43.7% in 2005). What is more, the relative abundance of very sensitive species of chironomids increased significantly (15%). These results confirm the improvement in the biological quality of the sediments initiated in 2005. In 2006 and 2015, the maximum depth (309 m), is populated only by oligochaetes that are very tolerant to pollution. The effect of the pit in the central plain accentuated by a multi-year stagnation of water following incomplete mixing since 2012, could explain these results. The use of many descriptive approaches and of bioindication of the benthic fauna in the sediments constitute appropriate tools to assess the development of the metabolic and trophic long term functioning of Lake Geneva.

Summary of bacteriological data (1998-2015)

The basic monitoring programme for the waters of Lake Geneva also includes analysis of the microbiological parameters. Microbes that are indicative of faecal contamination (*Eschericia coli,* enterococci), heterotrophic flora as also total coliforms and sulphite-reducing clostridia spores were investigated throughout the length of the water column (at 15 different depths) in two annual phases (at the end of the winter period, after homogenisation of the water and at the end of the summer stratification period). The results obtained for the 1998 to 2015 phases show that the thermal stratification of the water considerably slowed the diffusion of faecal matter below the thermocline (30 m).

The same does not apply for the bacterial spores (anaerobic ones) which survive for much longer; the latter were found at all depths. After winter homogenisation, the microbes – 'faecal indicators' – were also found at depth. The heterotrophic flora (total microbes) on the other hand, appeared to follow a different dynamic, since they are represented far more at great depth (up to 300 m).The analyses carried out in the untreated water in a drinking water treatment station were presented, for comparative purposes, and show the importance of having water available from the layers situated below the thermocline as also of a disinfectant treatment to avoid the occurrence of water being pumped out when it is contaminated with faecal matter.

3. PHYSICOCHEMICAL AND BIOLOGICAL DEVELOPMENT OF THE 'PETIT LAC' (SMALL LAKE) BETWEEN 2011 AND 2015

The dynamic of the superficial layers of the 'Petit Lac' is close to that of the 'Grand Lac' (Large Lake) with a high consumption of nutrients from the time of the mixing. The 'Petit Lac' being completely homogenised and re-oxygenised each year, the concentrations of oxygen at the bottom remain higher than legal requirements (> 4 mg/L). The average concentration of total phosphorus tends to stabilise at around $12\mu gP.L^{-1}$.

The annual biomasses of phytoplankton fluctuated enormously between 2011 and 2015. Micro plankton remained largely dominant. The filamentous algae, *Mougeotia gracillima*, continues to occur occasionally and, again, gives rise to considerable biomasses. Apart from the years of profuse production of *Mougeotia gracillima*, phytoplankton diversity increased. Cyanobacteria did not cause any toxicity problem for the period 2011-2015.

4. METAL AND MICROPOLLUTANTS IN THE WATER

Low, stable quantities of heavy metals, slight diminution of pesticides which is in line with regulatory stipulations for drinking water. Recurrent presence of medicinal residues.

Monitoring micro pollutants in the water of Lake Geneva is an important concern in the action plan for 2011-2020 and includes the monitoring of pesticides, medicinal residues and metals (total and dissolved) from the surface right to the bottom, as also with the monitoring of manganese at the bottom of the lake. The main aim of this programme of monitoring is to know in as much detail as possible the quality of raw water which, once treated, will enable the provision of drinking water supplies for more than 900,000 people.

The quantities of pesticides and of metals easily meet the requirements for the environment as also for drinking water as stipulated in Swiss and French legislation.

For medicinal residues, there are not, at present, reference values making it possible to estimate their impact. Metformin (antidiabetic) exceeds the concentrations of other residues detected by more than one order of magnitude. As for other substances (Carbamazepine, Carisoprodol, Carbocaine (Mepivacaine), Prilocaine), although not desirable, especially in water intended for drinking water supplies, their presence is confirmed year after year in Lake Geneva.

DRAINAGE BASIN OF LAKE GENEVA AD LOWER RHONE

1. MICROPOLLUTANTS IN THE WATERS OF THE RHONE

In spite of the diminishing load of phytosanitary products and the quantities of medicinal residues being slightly diminished, concentrations area still too high.

111 phytosanitary products, 28 pharmaceutical active ingredients, two corrosion inhibitors and one solvent (1,4 dioxane) have been systematically analysed in the waters of the Rhone upstream from Lake Geneva for the whole year 2015. Two phytosanitary products (glyphosate and amidosulfuron) exceed the requirements of the Ordinance on Water Protection (0.1 μg/L).

Of the 26 active ingredients studied, only one was found in the waters of the Rhone at lower concentrations than in the years preceding 2014. A maximum concentration of 0.84 μg/L was found for metformin of domestic origin. The industry remains active in establishing corrective measures and has decided to provide equipment for additional treatment in 2016.

In terms of annual fluctuation, the total quantities of phytosanitary products which transited through the Rhone in 2015 have diminished: 277 kg by comparison with 414 kg in 2014. The 1,4-dioxane load was estimated to be more than 750 kg for the year 2015 where it was 6 tonnes in 2014.

2. INTAKE FROM TRIBUTARIES TO LAKE GENEVA AND THE LOWER REACHES OF THE RHONE.

Lower intake of phosphorus in the lake but stable intake of nitrogen for the past 20 years

The nitrogen, phosphorus and chlorine intakes may present sometimes significant annual variations in connection with rainfall, but the long term development shows the significant effect of dephosphatation in the Lake Geneva basin's water treatment stations (STEP) on the lowering of phosphorus intake to the lake.

However, the absence of denitrification in the STEP combined with relatively stable agricultural fertiliser nitrates for the past 20 years, shows intakes stable in total mineral nitrogen. The intakes of chlorine have continued their progressive increase since the 1980s, but show for the first time a lowering of intakes for the Rhone upstream.

The rivers (the Rhone upstream and downstream, the Dranse, the Aubonne, the Venoge, the Versoix, the Arve and the Allondon) are all of good and very good quality according to the concentrations of nitrates, ammonium and phosphates measured.

3. QUALITY OF BATHING WATER

The sanitary monitoring of bathing water carried out in the summer season by the relevant authorities of the 3 Cantons (-Swiss administrative areas: Vaud, Valais and Geneva), the Department of Haute-Savoie (French administrative area), and the coastal communes, included 111 beaches in 2015. Microbiological monitoring concerning microbes used to test for faecal contamination (*Eschericia coli* and intestinal enterococci) shows that all the bathing waters are in accordance with regulations. According to the quantity of microbes present in the water, the results show that 85% of the beaches have water of excellent to good quality and 15% are of good to average quality.

4. WASTEWATER TREATMENT

Treatment efficiency of wastewater treatment plants (WWTP) was satisfying according to legal requirements but more efforts are required to meet the objectives of the 2011-2020 Action Plan. A first cross-territory assessment of the state of knowledge of spills through by-passes and storm overflows along sewage networks and at WWTP entrances underlined the necessity to better evaluate overflows to characterise the impact of wastewater systems on aquatic environments.

The WWTP treatment efficiency are good at the scale of CIPEL's territory and meet legal requirements regarding total phosphorus, BOD_5 and COD. In 2015, 222 WWTP were operating within the territory. In Lake Geneva's drainage basin specifically, 143 WWTP measured total phosphorus and accounted for a discharge of 95 tons, among which 69 post treatment and 26 through bypasses at the entrance or during treatment. The average treatment efficiency for total phosphorus has been stable for the past years (91% in 2015).

The estimation of the spills is nevertheless fragmented due to a lack of flow measuring systems in by-passes and storm overflows within the sewage networks. A survey, carried out across the territory in 2015, suggested that the spills at the plants entrances were underestimated by a factor of at least 2. The survey confirmed the importance of an improved knowledge of overflows along sewage networks when evaluating the impact of wastewater systems on aquatic environments : with a representativeness of 63% of the total treatment capacity of the territory, answers accounted for 637 points of overflow, among which only 37% were equipped by a spill detector, a flow monitoring system or modelled.

Regarding the quality of sewage collection systems, the specific flow rate in dry weather reached a minimum across the 2001-2015 span with a computed 250 $L \cdot PE^{-1} \cdot d^{-1}$ average for the territory. This rate remains high however, and could be linked to the particularly low pluviometry that year.

5. QUALITY ASSURANCE OF CHEMICAL MEASUREMENTS

During 2015, the CIPEL "Analytical Quality" working organised 5 interlaboratory comparisons assays concerning analyses of the main nutrient elements (nitrogen and phosphorus cycles, organic matter and major ions), pesticides and other micropollutants carried out on the natural water networks.

Statistical tests show that the results can all be considered to be good. The scatter corresponded to a "typical" scatter for these tests (samples preparation, analytical methods). There were only a few suspect or aberrant results. The recovery of additions to "spiked" samples was generally good for all parameters.