



How wastewater informs COVID-19 policy in Switzerland

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Wastewater

Governance and Regulation



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- SARS-CoV-2 is detectable in wastewater, with loads mirroring COVID-19 dynamics in the community.
- Wastewater is a cost-effective tool and better indicator of SARS-CoV-2 epidemiology during periods of insufficient testing or high positivity rates.
- Tracking COVID-19 through wastewater surveillance has been established in Switzerland, informing public health policy.

When COVID-19 was initially detected in Switzerland in February 2020, widespread clinical testing was unavailable. As the disease spread quickly throughout the country, the actual number of positive cases was vastly underestimated. One study suggests that **less than 10% of all COVID-19 cases** were detected. As a result, our understanding of the extent of COVID-19 disease during the first wave was limited and unreliable.

Early in the pandemic, the World Health Organization (WHO) advocated for extensive clinical testing and set guidelines under which case numbers can be considered reliable. It recommended that if more than 5% of tests are positive, there are likely substantially more COVID-19 cases in the community than are being detected. Indeed, during the first wave in Switzerland, the test positivity rate **peaked at more than 24%** on 23 March 2020, and stayed above 5% until late April. In Geneva, an estimated 11.6 COVID-19 infections occurred for every reported confirmed case; a remarkable **demonstration of insufficient testing** that was likely repeated throughout Switzerland – and beyond.

To complement clinical testing, we pondered if there was a better way to track the number of COVID-19 infections more accurately. Our team of scientists from Eawag and École Polytechnique Fédérale de Lausanne (EPFL) had experience in testing wastewater to track pharmaceutical and illicit drug use, and the seasonal dynamics of viruses that cause gastrointestinal and respiratory diseases. Through our contacts in the wastewater industry, in late February 2020 we started sampling wastewater from treatment plants in Lausanne, Lugano, and Zurich (Figure 1). We anticipated those wastewater samples contain insight into the extent of the COVID-19 outbreak in Switzerland; we just had to extract and understand the data.



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References



Figure 1 – Wastewater samples are collected from the influent as 24-hour composite samples to provide an average of the SARS-CoV-2 concentrations entering the treatment plant throughout the day. Image credit: Eawag, Esther Michel

Building on the work underway with other viruses, we turned our attention to refining a method for quantifying SARS-CoV-2 in wastewater samples. This required filtering and centrifuging the samples to remove large debris before concentrating the virus. From there, we extracted and cleaned the concentrated virus genome fragments before using specific reverse transcription-quantitative polymerase chain reaction (RT-qPCR) testing.

Time was of the essence. The Swiss Federal Council enacted increasingly stringent public health measures to control the spread of the virus. The disease outbreak exceeded clinical testing capacity and threatened to overwhelm the hospital system. Meanwhile, wastewater samples sat waiting in freezers at -20 degrees Celsius across the country. For months, we kept working on a robust, reproducible, and reliable method, overcoming lower than expected SARS-CoV-2 concentrations in our samples and finding ways to remove other substances that impacted our measurements.

By May 2020, as the easing of restrictions began in Switzerland, we had refined our methods and started to process the backlog of wastewater samples that had been sitting in the freezers. As the data rolled in, we saw that the SARS-CoV-2 RNA concentrations rose throughout March and started to fall within a few weeks, following the trajectory of the clinical cases. However, there was one striking difference, underscoring the limited accuracy of the existing testing regime: Wastewater samples indicated that the first wave in Lausanne peaked four days **later** than the clinical testing data had suggested. In contrast, in Lugano our wastewater testing indicated a peak that was six days **before** the clinical testing peak (Figure 2).

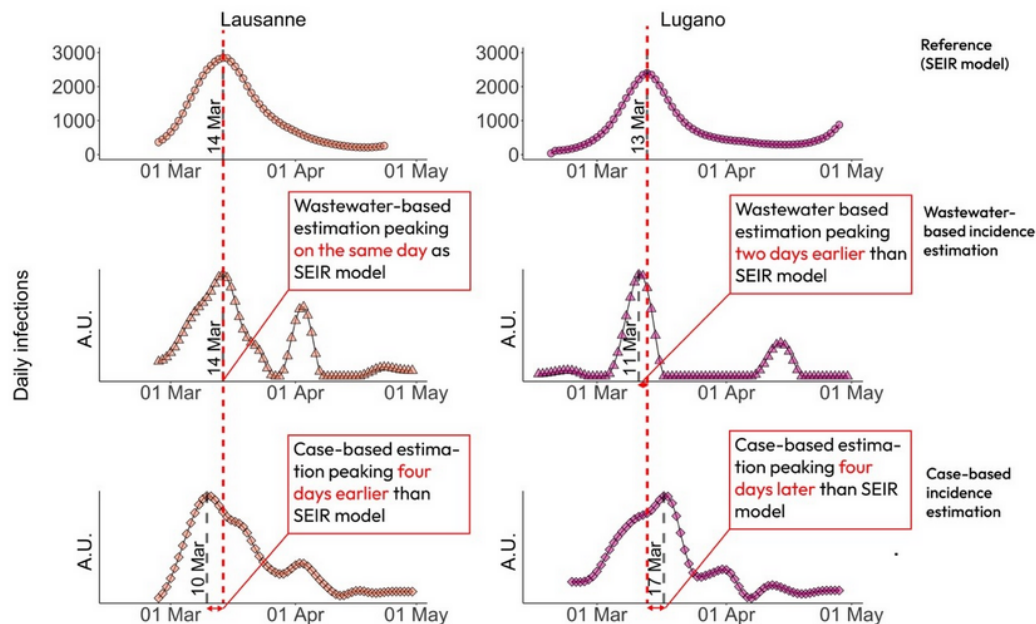


Figure 2 – Dynamics of SARS-CoV-2 RNA concentrations in wastewater suggest that COVID-19 cases during the first wave happened later in Lausanne and earlier in Lugano - contrary to reported confirmed cases. The wastewater results align with COVID-19 incidence dynamics estimated by the SEIR model, demonstrating that wastewater can provide more accurate insights into COVID-19 outbreaks. [Source](#)

Joseph Lemaitre, back then a Ph.D. researcher at EPFL working on optimising the control of cholera epidemics, had developed [epidemiological models](#) of Covid-19 in Switzerland. When Joseph applied these models to Lausanne and Lugano, the results aligned more closely with our wastewater data than with the reported confirmed cases (Figure 2). This proved that our methods were robust and wastewater monitoring can be a more accurate way of tracking the prevalence and trajectory of Covid-19 cases in the community.

Unfortunately, the findings from wastewater could not directly inform policy in Switzerland during the first wave as it took some months to establish and validate our methods. While the samples sat in freezers for those months, policy guidance was shaped by the limited clinical testing, hospitalisation, and death data available.

On 28 October 2020, that changed. We started reporting the loads of SARS-CoV-2 RNA in Zurich's wastewater twice per week. As confirmed cases increased in Fall 2020 within a regime of a rapidly expanded national testing strategy, the dynamics were tracked coincidentally with wastewater data. The public and policy makers took notice: federal funding allowed the research program to expand to six sentinel sites, along with canton-led surveillance in Graubünden, Zurich, and Basel to monitor treatment plants throughout the cantons. Public health actors and the general public in Switzerland can now rely on an independent method to track the dynamics of the pandemic through publicly available dashboards.

The initial EPFL and Eawag collaboration has been expanded through integration with other researchers within Switzerland and internationally with expertise in bioinformatics, mathematical modelling and phylodynamics. As a result of these collaborations, we can calculate the [effective reproductive number \(Re\) using the SARS-CoV-2](#) measurements in sewage and [detect the introduction of new variants](#) within the community by sequencing the RNA fragments of the virus present in the wastewater collected.

The logical next steps are to expand data acquisition from sentinel sites to more wastewater treatment plants and to transition from a research program to broadscale implementation by stakeholders and water practitioners. Incorporating wastewater-based epidemiology into national surveillance systems can help to inform transmission of endemic diseases like influenza, [respiratory syncytial virus](#), and [norovirus](#). And importantly, it is not a case of 'if' there is another pandemic, but 'when'. Should another pathogen emerge that causes similar social and economic disruption, we will already have invested in the infrastructure for wastewater to provide more accurate, real-time data when we need it most.