

# Contactless Water Quality Monitoring for Wastewater Treatment Plants

S. Blanc, Y. Cainaud, M. Dia, L. André, D. Sousa Lemos, Y. Liechti, N. Maamari

*This contactless water quality monitoring system for wastewater combines multispectral imaging with edge-based machine learning and application-specific illumination setup to monitor multiple water quality parameters such as turbidity, NH<sub>4</sub>, phosphate, etc., in a cost-effective and nearly maintenance-free manner. It includes machine learning models to predict water quality, achieving results that surpass current state-of-the-art methods.*

Realtime monitoring of water quality in urban drainage systems and wastewater treatment plants (WWTPs) is crucial for detecting pollutants that may contaminate the environment [1] and for effective operations of the treatment plant. Such monitoring is traditionally conducted through manual sampling campaigns or by using spectrophotometric probes immersed in water [2] or daily/weekly manual sampling. These methods are complex and costly to operate and maintain [3], often leading to delayed responses that can cause harm to the environment and facilities. Periodically and systematically monitoring water pollutant is however essential for optimizing treatment processes at WWTPs.

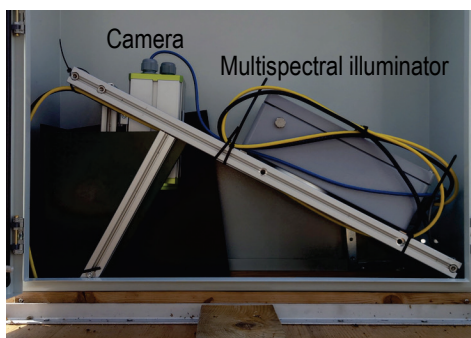


Figure 1: Prototype deployed at Altenrhein.

Water quality is assessed by measuring parameters like turbidity (TUR), NH<sub>4</sub>, phosphate (PO<sub>4</sub>), and chemical oxygen demand (COD). CSEM developed an industrialisation-ready prototype (Figure 1) for contactless measurement, consisting of multispectral imaging with specific illumination that extracts spectral characteristics and machine learning algorithms that predicts water quality. The system includes a UV-sensitive camera and multispectral illumination with 16 bands (250 nm to 940 nm), operated by an embedded computer that pushes data to the cloud for analysis.



Figure 2: Bird view of Zürich's wastewater treatment plant.

The system deployed at Altenrhein's WWTP (Figure 2) by Photrack AG, with plans for Zurich's WWTP by the end of 2024. Preliminary results illustrated in Figure 3 were obtained by

recording real wastewater at EAWAG's WWTP facility lab. These initial predictions show high correlation for turbidity  $R^2=0.85$  (error: 9.7%), and  $R^2=0.66$  (error: 21%) for NH<sub>4</sub>, and  $R^2=0.73$  (error: 39%) for PO<sub>4</sub>. WWTPs are enthusiastic about these early results. Improved accuracy is anticipated with the new prototype.

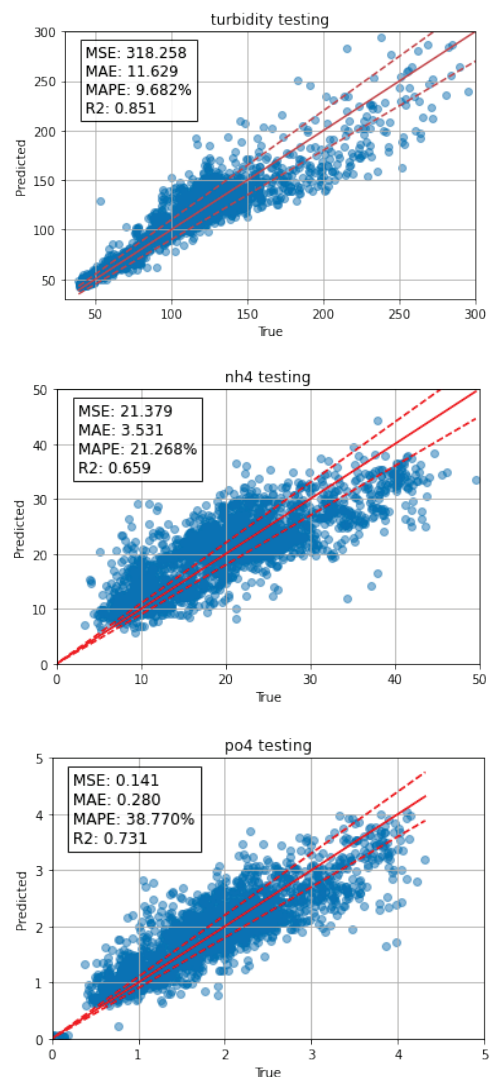


Figure 3: Predictions for turbidity, NH<sub>4</sub> and PO<sub>4</sub>.

CSEM's multispectral imaging systems offer tailored solutions optimized for data rate, size, accuracy, and cost. These systems are designed to meet specific application needs, ensuring high performance and reliability while maintaining cost-effectiveness.

[1] Alice Botturi, et. al. (2020), Combined sewer overflows: A critical review on best practice and innovative solutions to mitigate impacts on environment and human health, Critical Reviews in Environmental Science and Technology, 1585-1618 Vol. 51, (2021)

[2] R. Salgado Brito, et. al. (2012), In situ UV-VIS spectroscopy to estimate COD and TSS in wastewater drainage systems Urban Water Journal, 261-273 Vol. 11, (2014)

[3] G. Gruber, et. al. (2006), Practical aspects, experiences and strategies by using UV/VIS sensors for long-term sewer monitoring, Water Practice and Technology, Vol. 1, Issue 1