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Feasibility of leakage detection in lake pressure pipes using the Distributed Temperature Sensing Technology

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This contribution describes a feasibility study carried out in the laboratory for the detection of leakages in lake pressure pipes using high-resolution fiber-optic temperature measurements (DTS). The usage of the DTS technology provides spatiotemporal high-resolution temperature measurements along a fibre optic cable. An opto-electrical device serves both as a light emitter as well as a spectrometer for measuring the scattering of light. The fiber optic cable serves as linear sensor. Measurements can be taken at a spatial resolution of up to 25 cm with a temperature accuracy of higher than 0.1 °C.

The first warmer days after the winter stagnation provoke a temperature rise of superficial layers of lakes with barely stable temperature stratification. The warmer layer in the epilimnion differs 4 °C to 5 °C compared to the cold layers in the meta- or hypolimnion before water circulation in spring starts. The warmer water from the surface layer can be rinsed on the entire length of the pipe. Water intrudes at leakages by generating a slightly negative pressure in the pipe. This provokes a local temperature change, in case that the penetrating water (seawater) differs in temperature from the water pumped through the pipe. These temperature changes should be detectable and localized with a DTS cable introduced in the pipe.

A laboratory experiment was carried out to determine feasibility as well as limits and problems of this methodology. A 6 m long pipe, submerged in a water tank at constant temperature, was rinsed with water 5-10 ºC warmer than the water in the tank. Temperature measurements were taken continuously along the pipe. A negative pressure of 0.1 bar provoked the intrusion of colder water from the tank into the pipe through the leakages, resulting in local temperature changes. Experiments where conducted with different temperature gradients, leakage sizes, number of leaks as well as with different positioning of the DTS cable inside the pipe. Results showed that already small leakages (4mm) can be detected. Problems have arisen from the inside positioning of DTS cable, measuring a reduced temperature difference in the transition layer at the inside wall of the pipe.