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Temperature observations of shallow subsurface water inflows in a first order stream using Distributed Temperature Sensing

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High resolution temperature measurements are used in order to locate and quantify lateral inflows into a forested first order stream in central Luxembourg. If the temperature of a lateral inflow is known, the relative contribution of the inflow can be determined using a mass balance calculation under the assumption that other energy sources and sinks are negligible.

We measured the temperature of the stream with a, for hydrology, relatively new technique, namely a DTS (Distributed Temperature Sensing) fiber optic cable. In our experimental set-up, it is a fiber optic cable of 1300m length (max length can be up to 10km), capable of measuring temperature with a spatial resolution of 1 to 2 meter (depending on the system used) and a temporal resolution of 3 minutes with an accuracy of $\sim$0.05°C.

We applied 2 different methods to determine the temperature of the lateral inflows: 1) If the temperature upstream and downstream of an inflow are the same, the temperature of the lateral inflow should be the same too. 2) If the assumptions are made that the temperature and the relative contribution of the lateral inflow are constant over a certain period, both the temperature and the relative contribution can be determined using a mass balance for two moments in time.

The longitudinal temperature profiles of the stream indicated four points of lateral inflow. During the first try-out in May 2006 the temperature of the lateral inflows could

be considered to be constant over the whole measuring period of a week. However, observations in autumn 2007 shows that the temperature of the lateral inflows can fluctuate significantly and fast. This is supported by independent temperature measurements of the inflows.

These results have important implication for the usage of temperature as tracer for lateral subsurface inflow in streams. The presentation will discuss the possible reasons for the high temperature dynamics of the water sources and show how this can be used to quantify lateral inflows.