GLASSFIBER OPTICS TEMPERATURE OBSERVATIONS FOR DETECTION OF GROUNDWATER SEEPAGE IN POLDERS

W.M.J. Luxemburg, A.C. Hoes, M.C.Westhoff, N.C. van de Giesen

Delft University of Technology, Section Water Resources, Delft, The Netherlands
w.m.j.luxemburg@tudelft.nl

In this work we demonstrate the use of distributed temperature sensing (DTS) by fiber optic cable to locate seepage zones in ditches and canals in three polders in the Netherlands. Sometimes it is known that seepage occurs in certain water courses, but its exact locations might not be known.

The method, making use of a laser light that is transmitted and reflected in a glass fiber optic cable, enables to monitor temperature in relatively high resolution in time and space over periods as long as defined by the user. This proves to be a great advantage of the method, as seepage by temperature sensing is not necessarily always noticeable. The experiments showed that the temperature effect of seepage zones can vary in extent, or temporarily even completely vanish. Atmospheric heating and cooling can disturb the seepage signal by initiating turbulent processes or just by causing minimum temperature differences. When a discharge in the water course occurs seepage zones can even completely disappear from the temperature signature.

The results demonstrate that with the DTS technique the total ensemble of temperature effects on canals and ditches is recorded, and hence further analysis and common sense is required to confirm seepage. In most cases this can be solved by visual inspections of suspected seepage zones in search of other plausible explanations. Drainage pipes, side ditches and conducts are the most common features that give seepage like signatures.

The example of the observed temperature pattern in the Wieringermeerpolder, see figure 1 and 2, shows clearly a diurnal rhythm. There is obviously a delay in heating (and cooling) of water bodies through temperature differences of the atmosphere and radiation. A delay will be even more pronounced for temperature sensing on the bottom of a canal. Temperature measurements at locations that are shallower in a canal can therefore show a forward shift in time of the day and night rhythm compared to results of deeper locations. The observations of the Wieringermeerpolder hint to this explanation. Firstly, at the distance 300 m to 400 m the cable was closer to the sides of the canal and therefore less deep in the water, which caused a shift in the diurnal pattern. Secondly, due to a gradual change of depth along the canal the delay in heating or cooling resulted in a temperature wave. No discharge in the canal in the Wieringermeerpolder occurred during the period of observation. Seepage occurs at 180 meters. At 700 meters a pipe drains into the canal.

For the temperature sensing technique by fiber optics a pulsing laser light is transmitted into a glass fiber optic cable, in our case of 1300m length that was positioned on the bottom of the water courses. The reflected signal received is then analyzed for deformations of frequency and amplitude (the so-called Raman backscatters) that relatively simple can be related to temperature. The applied Sensornet system (Sentinel DTS-LR, London, England) delivers a mean temperature every meter, and when averaged over 10 minutes with an accuracy better than 0.1°C .

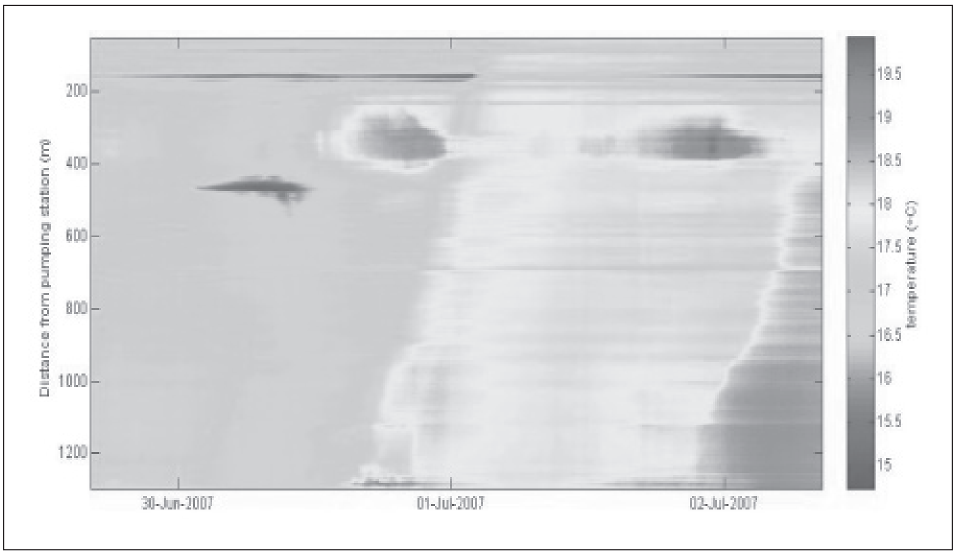

Figure 1. Example of the total ensemble of temperature effects along a 1300 meter cable in a canal in the Wieringermeerpolder

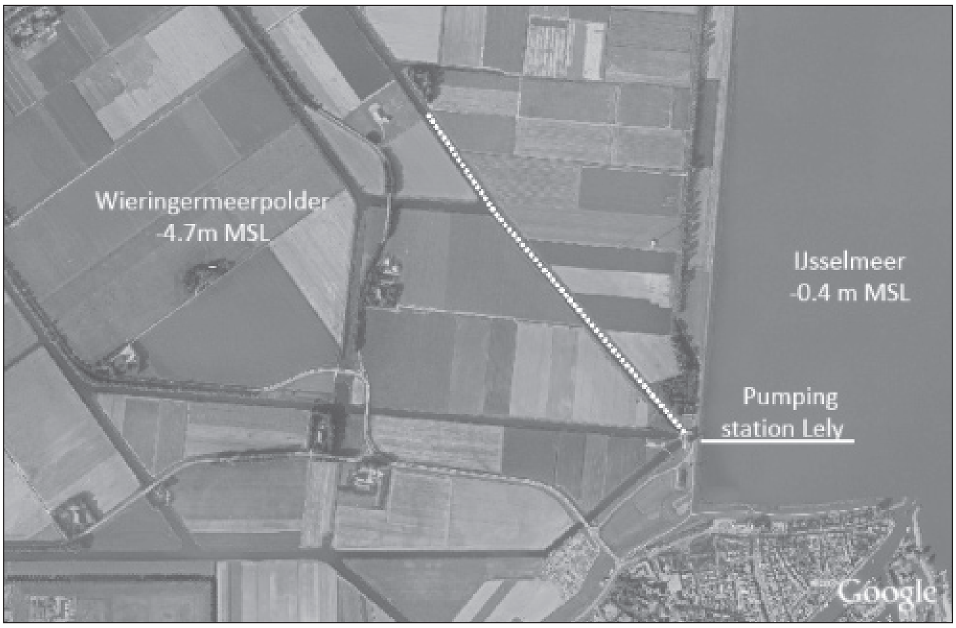

Figure 2. Location of the DTS cable in the Wieringermeerpolder