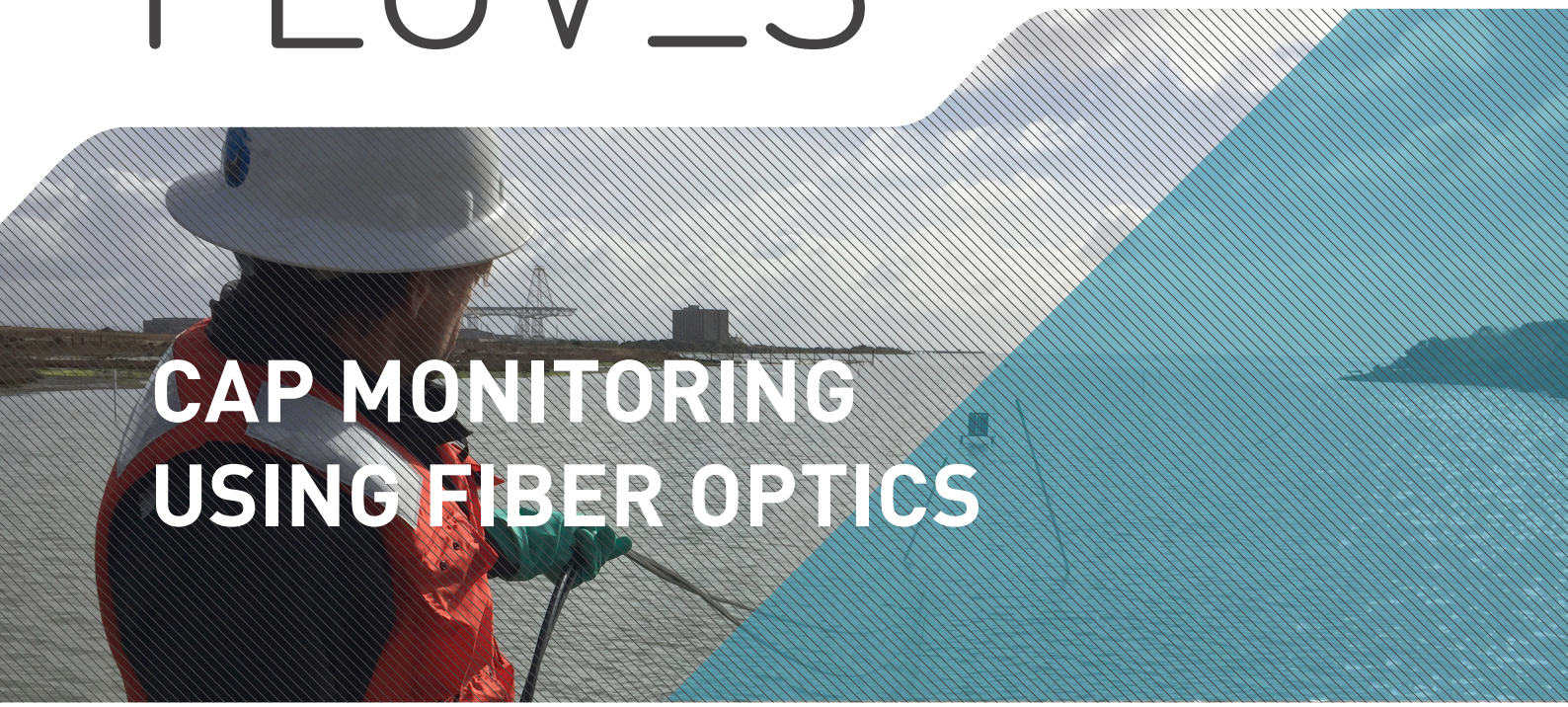
FLUVES



CAP MONITORING USING FIBER OPTICS

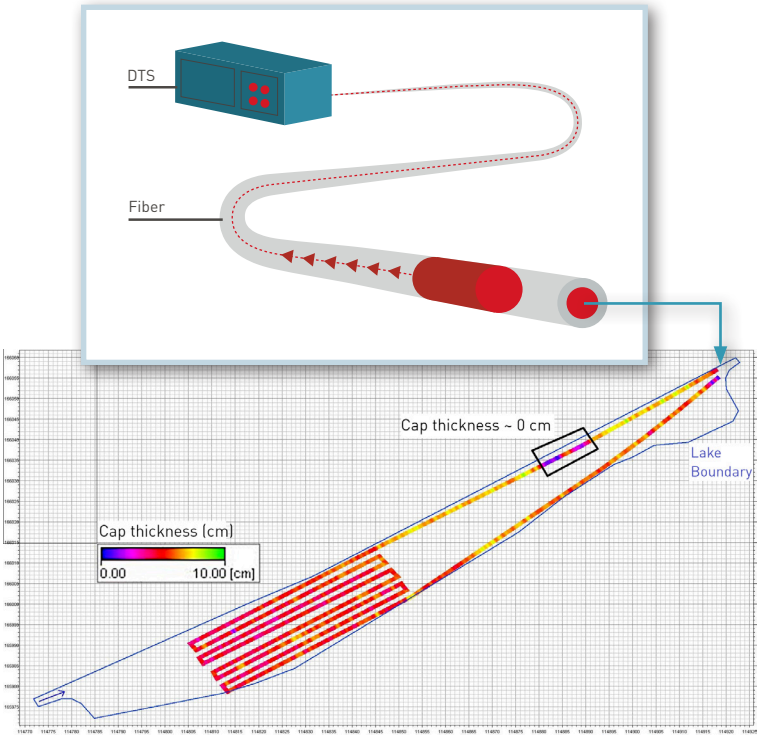
Distributed temperature sensing (DTS) enables Fluves to measure the ambient temperature along fiber optic cables. With a laser pulse, the temperature can be measured continuously every meter over up to 50 km of cable with a high level of accuracy (≤ 1°C). Temperatures of the fiber optic cable vary when in water and in or under sediments. If the fiber optic cable is placed in or under sediments, Fluves can use the varying temperatures to calculate the thickness of the sediment layer along the cable. Measurements can be performed at numerous locations along the cable on an hourly or daily basis, depending on the type of sediments. Also, seepage flow through the cap can be detected along every point of the fiber optic cable.

APPLICATIONS

- Monitor **Cap thickness** and **seepage** through cap
- Evaluate **EMNR/MNR sites, sediment traps, mine-tailing ponds**

FEATURES

- **Highly accurate:** Measure sediment levels with millimeter precision
- **Spatially distributed:** Monitor an entire site using a combination of line and point measurements
- **Cost-effective, continuous and long-term:** Generate hourly updates of sediment levels over several months or years for the price of a few multi-beam surveys
- **Autonomous:** Monitor without the need for frequent site survey visits
- **Robust:** Only field-proof cable is installed onsite; all sensitive hardware is installed off-site
- Based on well-tested **DTS** technology using standard fiber optic cables



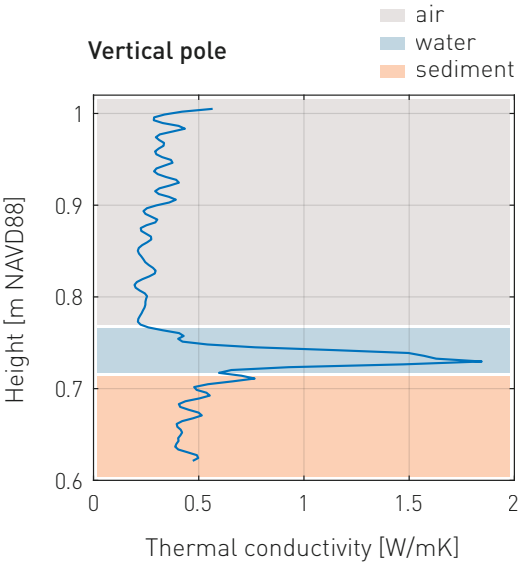
WORKING PRINCIPLES

When firing laser pulses in a fiber optic cable, a small fraction of the transmitted light is reflected and the intensity and frequency of the reflected light is dependent on the cable temperature.

By measuring this data using DTS, Fluves can determine the cable's ambient temperature continuously every meter along cables over up to 50 km (30 miles) with high accuracy (≤ 1°C). The cable temperature can be converted to sediment layer thickness using several methods.

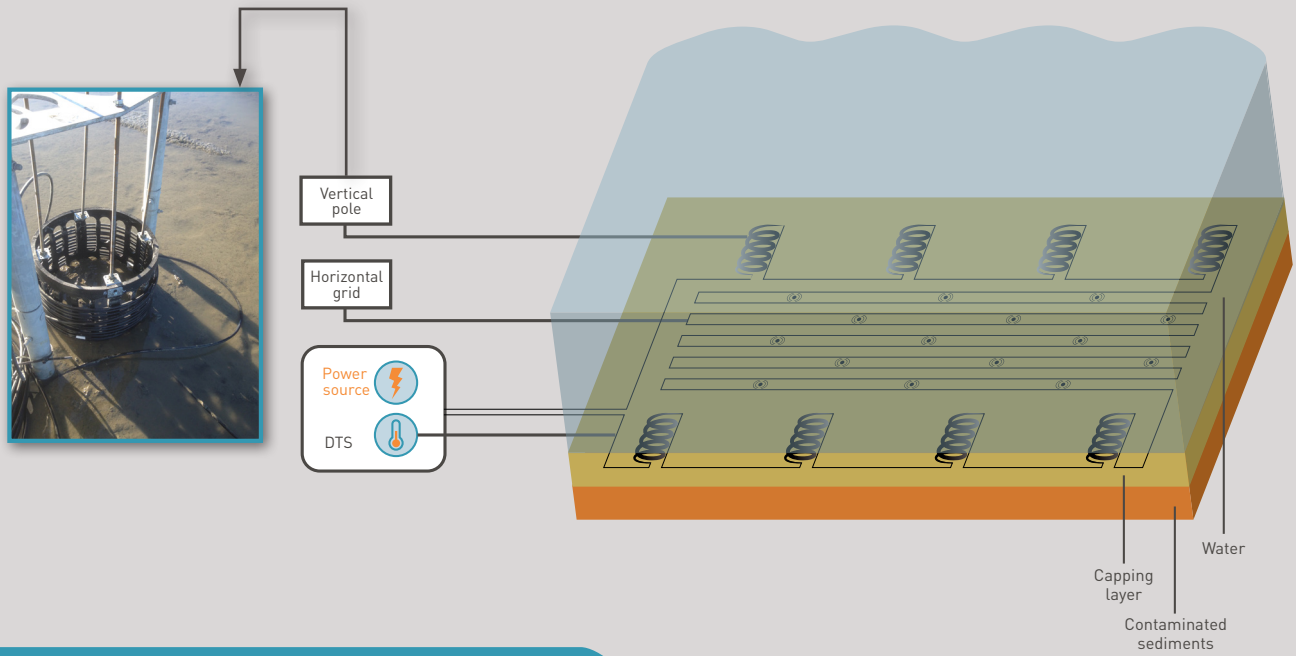
If the cable is coiled around a vertical pole (as illustrated in figure on the right), the sediment-water-air interfaces can be determined from the differing thermal conductivity properties of the materials, resulting in a vertical accuracy of down to 4 millimeters (0.16 in). If the cable is placed horizontally in a grid throughout the site, sediment thickness above the cable can be determined from the thermal insulation effect of the sediment during natural (day/night) or forced (through a heat pulse) temperature fluctuations.

Measurements can either be active, by generating a heat pulse in a conductor alongside the fiber optic cable, or passive, using natural temperature variations.

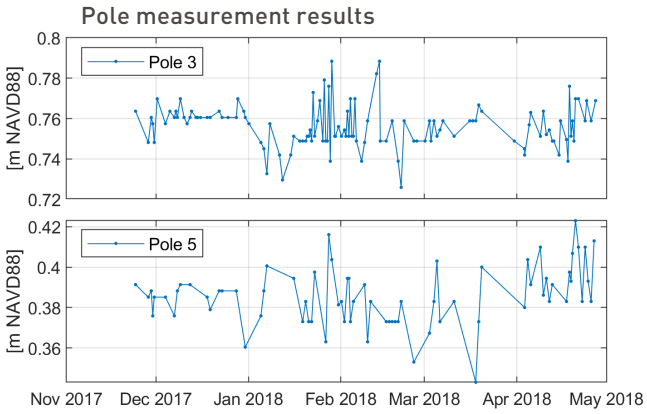


SITE CONFIGURATION

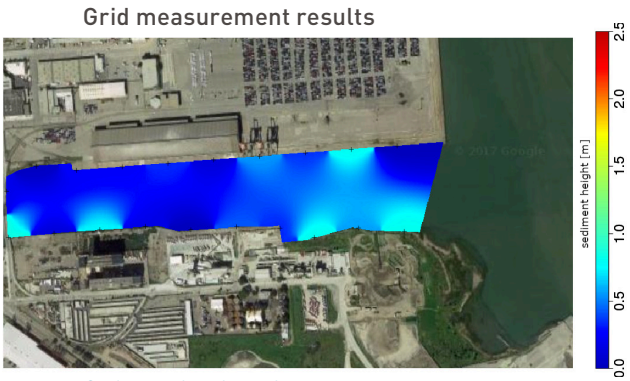
The full monitoring system consists of a fiber optic cable that covers the study site, and a land-based data unit that consists of a DTS unit, field laptop, power source (battery, generator, or grid connection), and telemetry. Depending on the size of the monitored site and the required accuracy, the fiber optic cable can be installed in a horizontal grid (to measure spatial patterns), coiled around vertical poles, or a combination of the two. Using a vertical pole, Fluves can measure minute changes in sediment height at individual points. Along a horizontal grid, measurements are less detailed but spatially distributed along the cable (one sensor every meter).



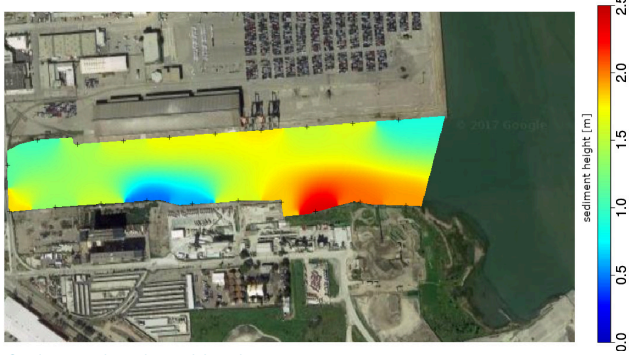
RESULTS



By measuring the sediment layer thickness continuously at multiple points, Fluves can determine a highly detailed overview of sedimentation and erosion processes over large areas. This enables continuous, spatio-temporal monitoring of sediment layer thickness for sediment capping, dredging, sediment traps, and other applications. Results are available in real time through an online web application.



Sediment height in January



Sediment height in March

INSTALLATION METHOD

Fluves installs the fiber optic cable from a small ship or platform and surveys the cable position at the start of the measurements using GPS equipment. In soft soils, Fluves uses anchoring systems to secure the vertical measuring poles. These ground anchors can be installed by using a small rotator, which can be completed from a small boat.

REFERENCE PROJECTS

Yosemite Slough 'Superfund site'
San Francisco, CA, 2017-2018
13.5 acres (5.5 ha)
End client: TIG Environmental

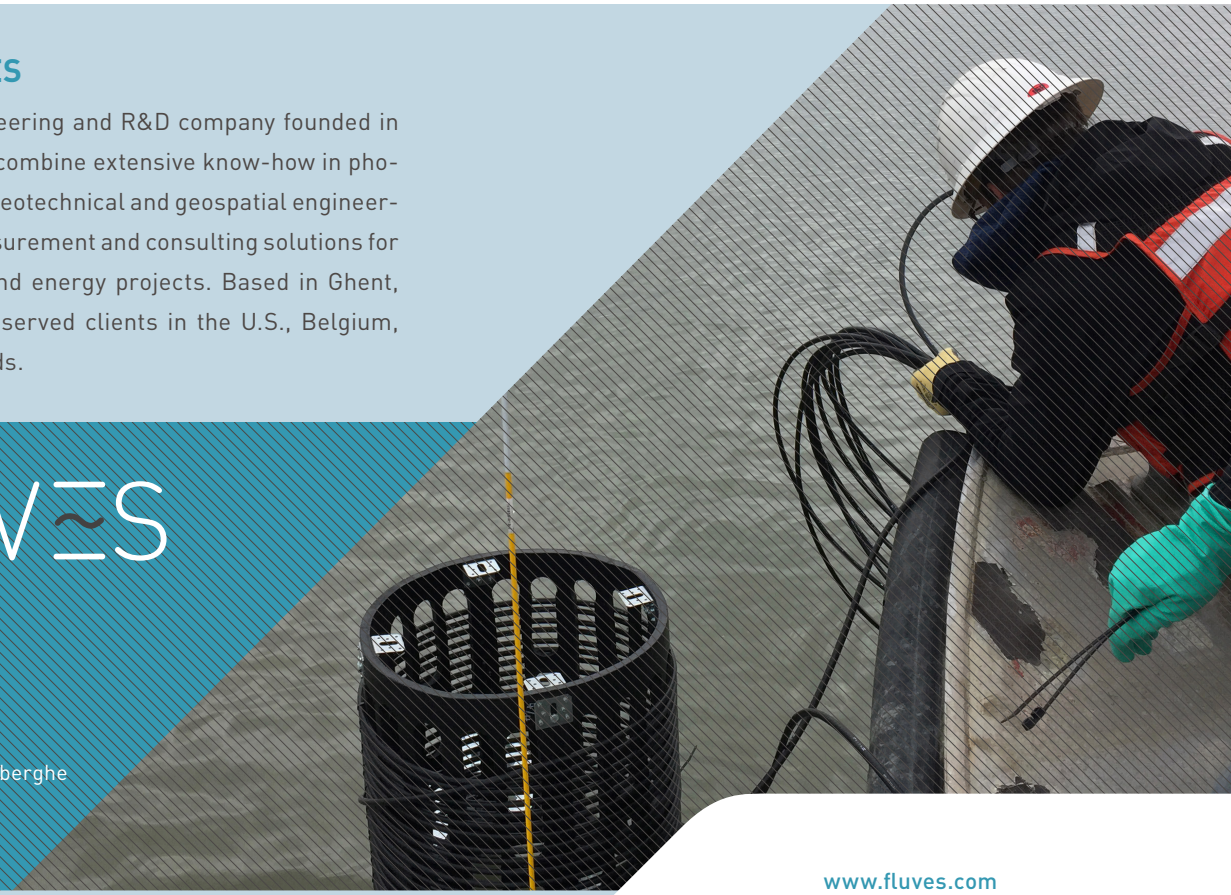
At this Superfund site, the MNR cap layer thickness was monitored at a 12-hour time resolution over a 6-month period, using a combination of 5 vertical poles and 2 km of fiber optic cable.

Moenebroekbeek Silt Trap
Lierde, Belgium, 2016-2019
0.5 acres (0.2 ha)
End client: Flemish Environmental Agency (VMM)

Sedimentation and erosion rates in a sediment pond were monitored at 9000 locations with a 1-hour resolution over a period of 2 years.

ABOUT FLUVES

Fluves is an engineering and R&D company founded in 2014. Our experts combine extensive know-how in photonics, electrical, geotechnical and geospatial engineering to provide measurement and consulting solutions for sediment, water and energy projects. Based in Ghent, Belgium, we have served clients in the U.S., Belgium, and the Netherlands.



FLUVES

Kerkstraat 106
9050 Gentbrugge
Belgium
T +32 9 346 85 30

Thomas Van Hoestenberghe
M +32 470 19 35 50
thomas@fluves.com