Case Study

Identifying phosphate sources in the River Avon

Our *in situ* phosphate sensor

- Onboard calibration for long-term accuracy
- Sensitive wet chemical method
- Submersible to 6000 m
- Can measure every 6 minutes
- User-swappable reagents
- Latest lab-on-chip technology

A Clearwater Sensors phosphate sensor was deployed in the river Avon in the United Kingdom to help determine sources of phosphate in the catchment. The sensor operated remotely for a 9-week period, sampling every 30 minutes, and communicating data in real time via a 3G network. The high sampling frequency revealed, for the first time, transient events and detailed hysteresis relationships between river discharge and phosphate concentration, helping identify sources of phosphate in the catchment.

Background

Phosphate is a natural nutrient in freshwater ecosystems such as rivers and lakes. Yet, phosphate pollution can lead to excessive algal growth, known as 'algal blooms'. Algal blooms can cause low oxygen levels that kill fish and other aquatic organisms, and can release toxins harmful to humans and animals. The effects of nutrient pollution are estimated to cost the US economy alone $4 billion per year [1].

Therefore, nutrient levels in water need to be measured and managed. The EU Water Framework Directive and United States Clean Water Act seek to address this problem. However, widespread monitoring of phosphate has proved difficult. The ClearWater Sensors Phosphate Sensor addresses this problem.

The challenge of continuous monitoring

Current phosphate monitoring practise is to collect manual water samples for analysis in a laboratory. This routine is very labour and resource intensive, which leads to high cost and infrequent measurements., Sparse datasets mean that pulses from transient events (e.g. storms) are missed, making it difficult to understand peak levels as well as sources and variability in phosphate pollution.

Some in-field phosphate analysers exist (using automated colourimetric methods), but these are either bulky, require mains power, or consume large quantities of fluid per sample. This leads to short duration monitoring.

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The solution

The ClearWater Sensors phosphate sensor delivers real-time phosphate measurements at a high sample rate. It produces in-field laboratory-quality data over periods up to several months. Frequent sampling and autonomous operation enable huge savings in the cost per sample, ensuring the reliable capture of transient events. Data is stored in the instrument and can be sent remotely in real time via telemetry to, for example, deliver alerts.

Key to achieving laboratory-quality data in the field is the use of the latest microfluidic technology, sometimes referred to as 'lab-on-chip'. By minimising the sample volumes required to take a measurement (less than 0.5 mL), the energy-per-sample and fluid consumption is dramatically reduced, enabling our instruments to take thousands of measurements per deployment.

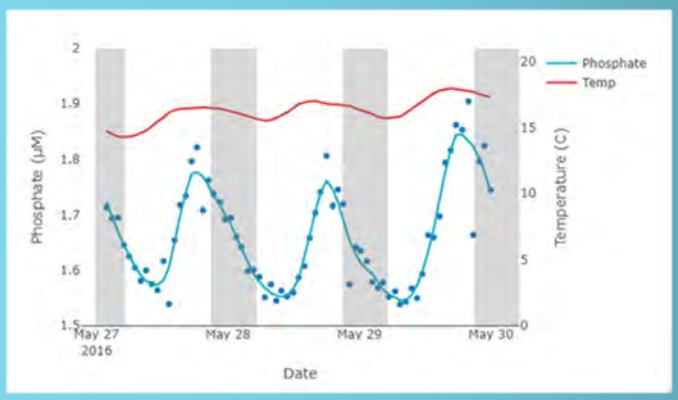
Measurement location

The Hampshire Avon is a chalk-fed river located in the southern part of the United Kingdom [2]. It is an area of phosphate concern, with anthropogenic phosphate sources such as agricultural fertilisers, animal waste and discharge from sewage treatment works. A phosphate sensor was deployed to make high frequency measurements to help understand the sources of phosphate in the catchment.

Sensor configuration

The sensor was submerged 1 m below the surface, suspended from a bracket extending out 0.5 m from the riverbank. It was configured to take one measurement every 30 minutes. No mains power was available at this remote location, so the instrument was powered by a 12 V battery and solar panel located on the riverbank. Data was telemetered using 3G so that it was accessible in real-time via a web portal.

Easy sensor deployment and recovery. No mains power needed, allows convenient monitoring in remote locations.



3-day extract of sensor data revealing strong diurnal variation in phosphate. The full 9-week dataset [2] revealed detailed hysteresis relationships between river discharge and phosphate concentration, helping to identify sources of phosphate in the catchment.

Want to find out more?

Please contact us for more information on how the ClearWater phosphate sensor and other chemical sensors can be used for your application.

ClearWater SENSORS

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References

[1] Dodds, Bouska, Eitzmann, Pilger, Pitts, Riley, Schloesser & Thornbrugh (2009) Eutrophication of U.S. Freshwaters: Analysis of Potential Economic Damages, Environmental Science & Technology. 43 (1), 12-19

[2] Clinton-Bailey, Grand, Beaton, Nightingale, Owsianka, Slavik, Connelly, Cardwell & Mowlem (2017) A Lab-on-Chip Analyzer for in Situ Measurement of Soluble Reactive Phosphate: Improved Phosphate Blue Assay and Application to Fluvial Monitoring, Environmental Science & Technology. 51 (17), 9989-9995