

High resolution monitoring of dissolved organic matter and nutrient fluxes for the Birmingham Institute of Forest Research (BIFoR)

Background

The Birmingham Institute of Forest Research (BIFoR) was founded in November 2013 and aims to become an internationally leading Institute. With >£15M investment BIFoR is in the process of establishing a unique long-term experimental facility, staffed by globally leading researchers. One of the key challenges to be addressed is the impact of climate and environmental change on woodlands.



Fig. 2. Location of monitoring stations.



Fig. 1. Field Site location.

The development of a field facility at a semi-natural woodland in South Staffordshire (Fig. 1) will enable trees to be exposed to elevated concentrations of carbon dioxide and changes in forest biogeochemistry monitored. RS Hydro has been tasked with instrumenting the stream that flows through the field site (Figs. 2 & 4), upstream and downstream of the woodland, to enable real-time measurement (and logging) of carbon and nitrogen fluxes,

tryptophan-like (TLF) and humic-like (CDOM) fluorescence, along with a suite of conventional water quality parameters.

Instrumentation and monitoring approach



Fig. 3. Monitoring kiosk with Manta 2 (left) Opus (centre) and ISCO pump sampler head (right).

and CDOM) with RS Hydro's bespoke fluorescence calibration and correction package (see below for details) have also been integrated with the versatile Manta 2 platform. A Trios Opus UV Spectrometer,

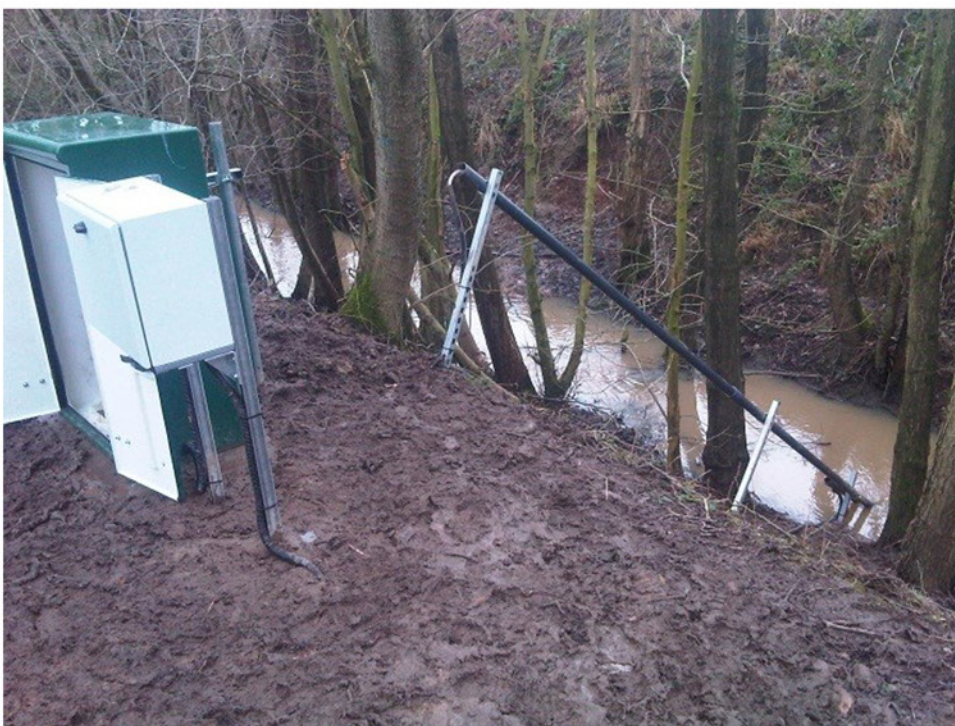


Fig. 4. Upstream monitoring site displaying innovative pumping solution.

RS Hydro have been contracted to provide a wide range of mobile monitoring equipment (including; ISCO pump samplers, Solinst peristaltic pumps and CT2X conductivity data loggers) and two permanent water quality monitoring stations with telemetry capabilities. At each station a suite of conventional water quality parameters (i.e. electrical conductivity, pH, dissolved oxygen, turbidity, water temperature) are recorded using a Manta 2 multi-parameter sonde. In addition to the conventional Manta 2 setup, two fluorometers (tryptophan-like measuring, Nitrate, Nitrite and Dissolved Organic Carbon (DOC) has also been installed at each site. In addition to these parameters the Opus can also log continuous absorption spectra from 200nm to 360nm. These data can provide useful information on molecular weight and aromaticity of organic matter. To complete the setup an SDI-12 level sensor has been installed to provide accurate water level readings at each monitoring site.

Due to significant periods of low water level anticipated during summer months in-stream deployment of the

sensor platform was not possible. To overcome this challenge RS Hydro designed a bankside panel, mounted through-flow system housed in a robust kiosk (Fig. 3). As BIFoR required high resolution monitoring (10 min intervals) a powerful but reliable and highly durable pumping system was required, particularly as one of the sites was located >10m from the channel (Fig. 4). To meet the criteria an ISCO 3700 pump head and control module was used. This unit has a diverse range of programmable settings (including purging and cleaning) and could be conveniently mounted in the monitoring kiosk. All sensors are triggered to take measurements every 10 mins by the Adcon A753 telemetry unit and readings are then transmitted via GPRS to a central server every 3hrs.

ISCO 3700 automatic water samplers will be deployed at the two monitoring stations to collect samples for laboratory analysis. This will enable a robust field based calibration to be developed for DOC, Nitrate, Nitrite, TLF and CDOM. Further analysis including fluorescence excitation - emission matrix spectroscopy and ion chromatography will be conducted on collected water samples once transported back to laboratories at the University of Birmingham.

RS Hydro custom fluorometer calibration

Fluorescence spectroscopy is a highly sensitive and selective optical technique that has been widely used to quantify and characterise the composition of dissolved organic

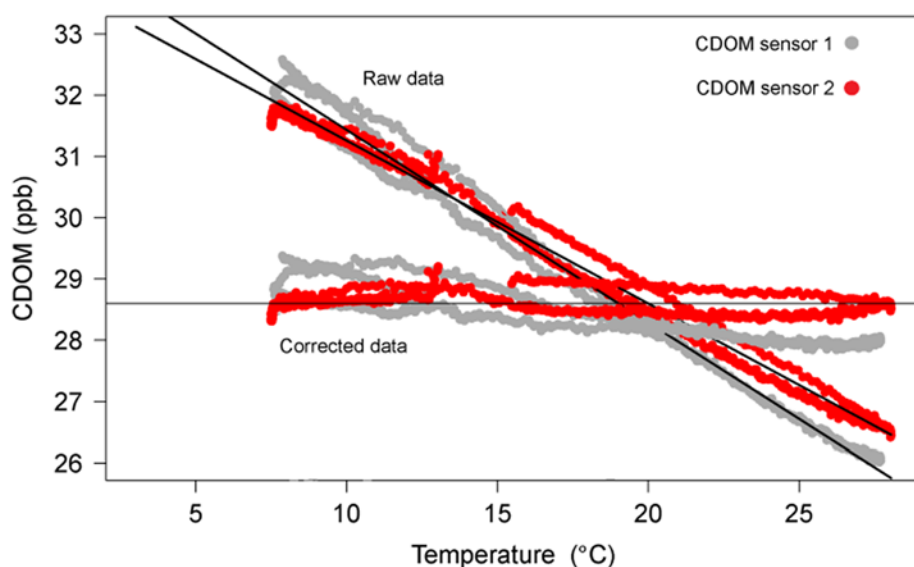


Fig. 5. Temperature correction RS Hydro calibration.

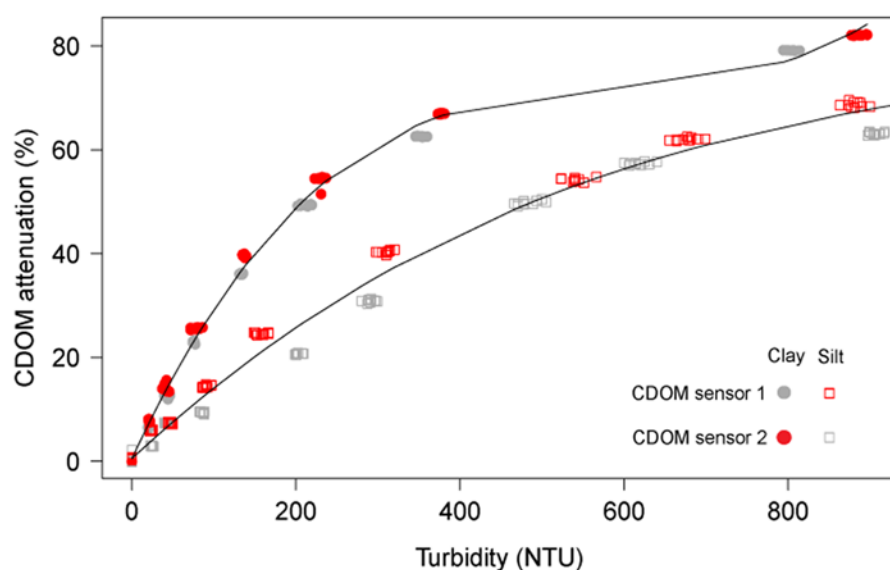


Fig. 6. Laboratory derived turbidity response used to create compensation algorithms.

matter (DOM). However, this has historically been limited to the laboratory due to expensive power hungry instruments. In recent years advances in LED technology have led to the development of commercially available fluorometers for measuring CDOM and TLF. However, potential interference from other environmental parameters (e.g. turbidity and temperature) is often ignored and is not routinely accounted for in manufacturer compensation algorithms.

As part of a Knowledge Transfer Project, RS Hydro and the University of Birmingham have been undertaking detailed research exploring potential temperature and turbidity effects on in-situ fluorescence measurements. Robust temperature and turbidity correction procedures have been devised and rigorously tested. For the BIFoR installation both temperature correction (Fig. 5) and turbidity correction algorithm (Fig. 6) were undertaken for both the CDOM and tryptophan fluorometers prior to deployment.

Preliminary Data

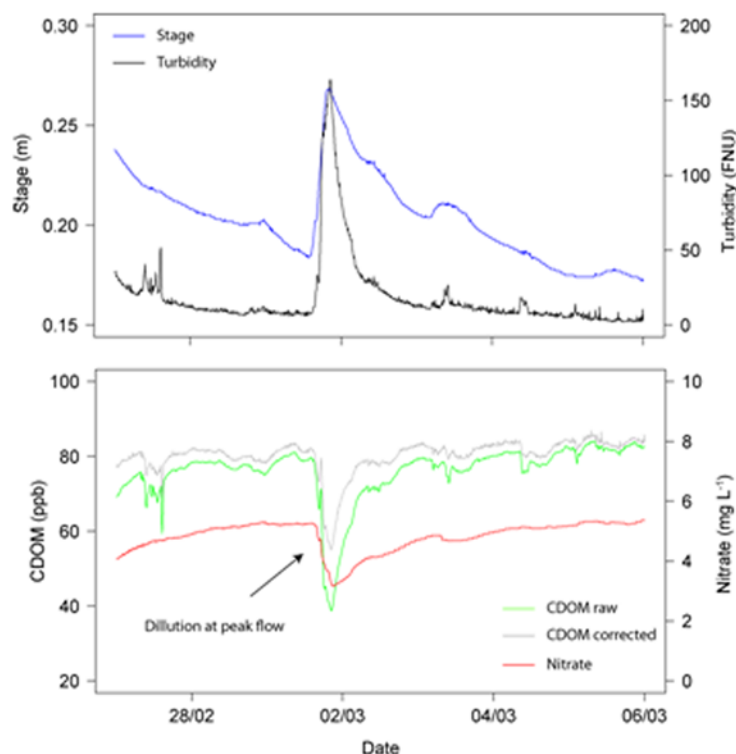


Fig. 7. Water quality data collected from the upstream monitoring site.

High resolution water quality records are already being captured and stored on the central server at RS Hydro. Fig. 7 displays some of the data already collected, with a distinct dilution of CDOM and Nitrate concentrations apparent during a high flow event (02/03/15). It is important to note the systematic bias in the uncorrected data (green line) when compared to the turbidity and temperature corrected records (grey line).

The initial data collection will primarily be used to refine cleaning protocols and assess power consumption of the monitoring stations. Once this period has been completed comprehensive field calibrations will be conducted to assure all optical sensors accurately quantify nutrient and organic matter concentrations, thus enabling a robust baseline to be established before experimentation begins.



Manta 2 - a versatile platform for integrating a wide range of water quality sensors.



Opus - a robust UV-VIS spectrophotometer for in-situ absorbance scans.