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# EXO2 Sondes

ESTUARY RESEARCH PROJECT HIGHLIGHTS ADVANTAGES OF  
CONTINUOUS MONITORING IN CHRISTCHURCH HARBOUR

Application Note  
XAUK OC201-01 1215



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# CHRISTCHURCH HARBOUR NERC Macronutrient Cycles Programme

YSI Environmental Monitoring Systems

Application Note XAUK OC201-01 1215

Researchers from the south coast of England have established a small network of monitoring instruments in Christchurch Harbour and associated rivers to study the effects of weather events on water quality, and to better understand the magnitude and spatial/temporal variation of macronutrient fluxes - nitrogen (N), carbon (C) and phosphorus (P). The project, which is financed by a Natural Environmental Research Council grant, has involved the installation of three continuous monitoring stations; one in the harbour itself, a second in the river Avon and a third in the river Stour. Each monitoring station includes a Xylem YSI EXO2 multiparameter water quality monitoring sonde and a Xylem Storm3 Data logger that wirelessly transmits the data to the Storm Central 'cloud' hosted data collection platform so that readings can be viewed on the project website

[www.christchurch-macronutrients.org.uk](http://www.christchurch-macronutrients.org.uk).

*With over a year of data, project lead Prof. Duncan Purdie says: "We were fortunate with the storms that took place over the winter of 2013/14, because we were able to gather excellent high frequency data on nutrient fluxes and water quality during severe weather, which has dramatically improved our understanding of the effect extreme river flows have on nutrient fluxes into the estuary. The monitoring systems worked very well during this period and we were particularly impressed with the performance of the EXO2 sondes and the Storm loggers."*

## BACKGROUND

Human activities have enhanced global cycles of N and P by around 100% and 400% respectively since the industrial revolution, and this is having a major impact on the world's water resources, resulting in serious detrimental effects on water habitats leading to, algal blooms and eutrophication. However, our knowledge of macronutrient fluxes through estuaries is limited and estimates are often based on low sampling frequencies leading to large-scale approximations, so there is a need to better understand fluxes of N and P through estuaries and how their behaviour is impacted by processes operating over a range of temporal and spatial scales.



YSI EXO2 sonde downloading via Bluetooth

**"...we were able to gather excellent high frequency data on nutrient fluxes and water quality during severe weather..."**



Scan or click the QR code to download readings from the project website.



Equipment deployed on the River Avon

In addition to monitoring macronutrient fluxes, the project has investigated the eutrophication status of the estuary with summer reduced river flows leading to longer water residence times resulting in algal blooms, that can cause reduced dissolved oxygen levels which threatens migratory fish, for example. The project has also sought to determine whether high river flows during the winter affect the estuarine benthic habitat and local fisheries.

Historically, most water quality monitoring in rivers and estuaries has taken place at fixed time intervals that are spaced too far apart to capture severe weather events, so there is a heightened demand for instruments that are able to operate unattended for extended periods. This means that they must be robust, resistant to fouling, and able to operate on low levels of power without requiring frequent recalibration. Low power remote telemetry capability also reduces the frequency of site visits and thereby further lowers operational costs.

## MONITORING SITES

Christchurch Harbour is a particularly interesting and important water resource. It was chosen for this project because it is a relatively small and constrained estuary with easily accessible sites for monitoring. The estuary has two main rivers (the Stour and Hampshire, Avon) feeding into it and exchange with coastal waters is provided by a narrow (~45 m) channel at Mundeford. The two river catchments have similar characteristics; both containing high proportions of chalk in the upper and middle reaches and tertiary sands and gravels in their lower sections. The River Avon is designated as a Natura 2000 site because it supports internationally rare species such as floating water crowfoot and starwort; and fish species such as brook lamprey, migratory salmon, sea lamprey and bullhead. The Hampshire Avon is one of the most important chalk river systems in the UK, with over 180 species of river plant, one of the most diverse fish populations, and a wide range of river invertebrates.



Equipment deployed on the River Stour

In addition, the river is important for its populations of water vole and otter. All of these species are affected by river quality.

## WATER MONITORING CHALLENGES

The Environment Agency is already working with local water companies to implement improvements to sewage treatment works that will reduce phosphate levels in the discharges from these plants. However, there is also a requirement to lower macronutrients from other sources (eg farming), so it is convenient that a further project is being conducted in the upper reaches of the Avon, also involving continuous water quality monitoring. Known as the Avon Demonstration Test Catchment project (Avon DTC), this seeks to test the hypothesis that it is possible to cost-effectively reduce the impact of agricultural diffuse water pollution on ecological function while maintaining sustainable food production through the implementation of multiple on-farm mitigation measures. As a result, the knowledge gained from the Avon DTC project will complement that from the Christchurch Harbour Macronutrients Project.

The Christchurch Harbour project is one of four consortium projects funded by the NERC Macronutrient Cycles Programme. The project's consortium is made up of a team of scientists from the Universities of Southampton, Portsmouth and East Anglia, and the National Oceanography Centre, Southampton. The monitoring equipment was first installed in late 2013 and early 2014, and is due to run for 3.5 years. In conjunction with modelling, the monitoring data will enable the scientists to produce an accurate assessment of the impact of nutrients entering the estuary during short-term storm increased flows in the two rivers.



YSI EXO2 multiparameter sonde with titanium bulkhead

Data from the study are being used to create a powerful statistical model of the distribution of excess phosphates and nitrates, how they transfer from rivers, through estuaries and into the coastal seas and the role that storms play in this process. The team anticipates that this will allow policy makers to make more informed decisions about how to reduce nitrate and phosphate pollution in estuaries.

### CONTINUOUS MONITORING EQUIPMENT

The YSI EXO2 sondes are designed to run on low power for long-term deployments. Each sonde is able to accommodate a large number of sensors and in this project they included dissolved oxygen, conductivity, temperature, turbidity, chlorophyll, depth and pH. The EXO sondes contain internal batteries and can be deployed on their own, but in order to provide near real-time data to the 'Storm Central' website, they were each connected to a Storm datalogger with a solar powered battery pack.

A novel 'lab on a chip' nitrate sensor also forms part of the monitoring system. Developed by scientists at the NOC, the nitrate monitor performs miniature colorimetric nitrate analysis at hourly intervals, with a serial output to the Storm datalogger. Consequently the nitrate data has been incorporated with that from the EXO sondes.

The EXO sonde at the Christchurch Harbour pontoon was also fitted with a fDOM sensor (Fluorescent Dissolved Organic Matter) which provides greater insight into water quality; typically displaying an inverse relationship with salinity revealing high DOM levels in the freshwater entering the estuary.

The monitoring system has the ability to output alarms when pre-set conditions occur, including relationships between different sensors. Alarms can trigger emails, and text messages are also possible with minor additional equipment, however the alarm function was not enabled for this project. Automatic water samplers were also employed by the project, taking samples at pre-set intervals, but if necessary the samplers could be set to initiate sample collection when certain conditions occur, such as a lowering of river conductivity caused by a surge of fresh water.

### EQUIPMENT

#### YSI EXO2 Sensors

- Temperature
- Conductivity/salinity
- pH
- Dissolved oxygen
- Turbidity
- Chlorophyll
- Depth
- FDOM (estuary pontoon only)

#### ISCO Water Sample Analysis (HgCl<sub>2</sub> preserved)

- Nitrate
- Nitrite
- Phosphate
- Silicate
- Salinity (pontoon only)

YSI EXO2 sensors (top) and Storm logger cabinet and water sampler (bottom)



**"...we were particularly impressed with the performance of the EXO2 sondes and the Storm loggers."**

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Xylem Analytics UK manufactures environmental monitoring instruments and systems. Formerly known as YSI, the group is a market leader with a reputation for high levels of accuracy and reliability. The company's water quality measuring instruments are designed for both laboratory and field use. In addition to bench top and hand-held instruments, Xylem Analytics also builds monitoring systems and wireless networks that are able to operate in remote locations and challenging environments. The company's water quality monitoring sondes can be fitted with a wide variety of sensors including dissolved oxygen, PH, temperature, turbidity, conductivity, salinity, ORP, chlorophyll, open-channel flow, vented level, ammonia, chloride, rhodamine, depth photo synthetically active radiation.

Xylem brands represented include; YSI, SonTek, Aanderaa, MJK and WTW.



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