

**CSAR Blue Economy 15<sup>th</sup> September 2022**




Professor Carlos Garcia De Leaniz – CSAR

*Write up 20<sup>th</sup> September 2022 (R. Browne)*

The Centre for Sustainable Aquatic Research (CSAR) at Swansea University (SU) organised a very interesting event titled “Advancing Aquaculture within The Blue Economy” on the 15<sup>th</sup> and 16<sup>th</sup> of September 2022 at which STREAM project members attended and gave talks that provided overviews of the work of the project along with actual demonstrations of the sensors being developed by the Welsh Centre for Printing and Coating (WCPC). There were 35 attendees from academia, industry and Welsh Government.



Professor Carlos Garcia De Leaniz (CSAR) introduced the conference, outlining the agenda for the 15<sup>th</sup> and 16<sup>th</sup> (2022) and spoke about the Blue Economy and some of the opportunities and pressures it faced.



STREAM is part funded by the European Regional Development Fund (ERDF) through the Ireland-Wales Cooperation programme

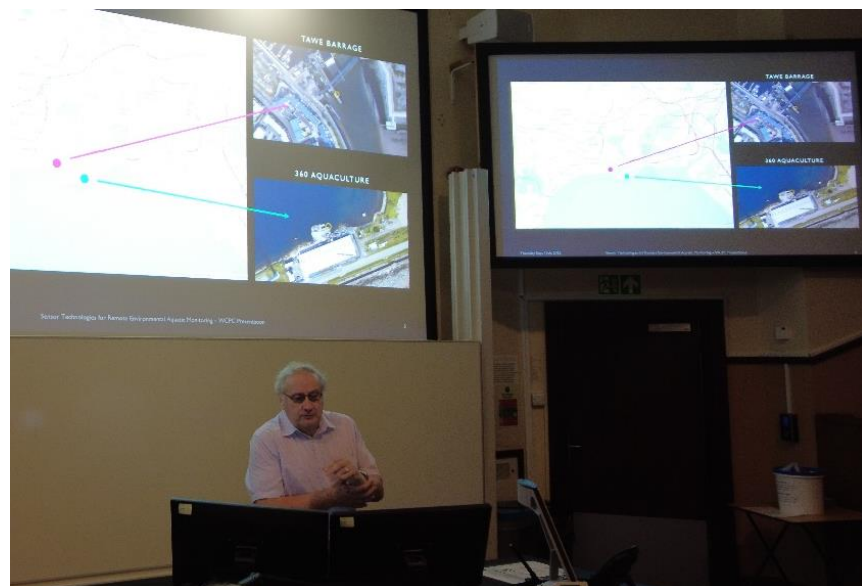


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Professor Garcia De Leaniz talk was followed by Dr Ronan Browne who provided “An overview of sensor technologies being used by the STREAM project to monitor the Irish environment”.

Professor David Gethin (WPCP) described the STREAM work, commercial sensors and those sensors he and his colleagues at the WPCP are in the process of developing and testing.



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Two STREAM posters were also provided by the WCPC (B. Clifford, T. Mortensen, J. Lau and D. Gethin) at the event that covered many aspects of the STREAM project.

### Sensor Technologies for Remote Environmental and Aquatic Monitoring

Prifysgol Abertawe Swansea University  
Ben Clifford\*, Tim Mortensen, John Lau, David Gethin\*\*

**STREAM: Sensor Technologies for Remote Environmental Aquatic Monitoring**

As part of the STREAM project, researchers in the Welsh Centre for Printing and Coating (WCPC) at Swansea University are developing a modular water quality sensor platform designed to incorporate low-cost printed sensors focused initially on pH, temperature, conductivity and dissolved oxygen properties.

This research focuses on the use of advanced printing technologies to create low-cost volume sensors with high stability and resolution whilst overcoming the challenges of the harsh environment, biofouling, and lifetime.

**£** ↓

**Aerated Jet Dispersion (AJD)** is a digital process allowing designs to be rapidly created, modified, and printed whilst using small quantities of ink. Within the STREAM project, the technique is being used to prototype sensors, evaluate designs and materials, and to produce the temperature and conductivity sensors for deployment.

Screen printing is one of the most commonly used printing technologies in the field of printed electronics used extensively in sensor production. In production environments, screen printers can produce thousands of sensors each minute. In the STREAM project screen printing is being used to produce the pH and dissolved oxygen multilayer devices.

One of the key design considerations in safety measurement, is the cell concept of the sensor with different values being optimal for fresh, brackish and sea water. Printing as a fabrication technique allows the tuning of the cell constant and therefore sensor for the particular environment without having to redo the optimisation and development stages.

A modular design for the control and measurement electronics and enclosure has been developed in-house at Swansea University supporting up to 6 rigid ceramic substrates, with each substrate supporting up to 2 individual sensors giving a total of 12 possible sensors when fully populated.

The use of a ceramic substrate enables the use of high temperature processing of the various inks and allows the substrate to form a sealing surface against an O-ring. Each substrate can be individually replaced at end of life on location, and the additional sensor ports allow for overlap of successive sensors with the previous batch to ensure continuity in the collected data.

**Sensor Fabrication**  
Printing of remaining temperature and conductivity sensors. Printing and characterisation of pH and DO sensors.

**Calibration of Sensors**  
Calibration and deployment of sensor systems around Swansea bay and southern Ireland.

**STREAM Project Concludes**  
STREAM project concludes end of 2023. Currently seeking follow-on funding opportunities and collaborations.

**Assembly and testing of sensor systems** in partnership with CSAR including wear tightness, remote data transmission, and power.

**Monitoring of Deployments**  
Monitoring and maintenance of existing deployments, increase sensor network size, dissemination of work.

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### Sensor Technologies for Remote Environmental and Aquatic Monitoring

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Ben Clifford\*, Tim Mortensen, John Lau, David Gethin\*\*

**STREAM: Sensor Technologies for Remote Environmental Aquatic Monitoring**

The STREAM project is a collaboration between both sides of the Irish Sea to better understand the impact of climate change; lower the cost of estuarine and marine observation and accelerate the acquisition of data required for modelling and mitigation planning.

The project aims to develop sensors capable of providing real-time environmental data and disseminating this data via web portals and mobile applications to organisations responsible for protecting and improving Welsh and Irish waters.

**Funding:** ERDF, Wales Government, Swansea University, SE TU, MTU

**Total Budget:** £1.4M  
**ERDF:** £1.1M  
**Wales Gov:** £1.1M  
**Duration:** 18 Months

As part of the STREAM project, multiple commercially available sensor systems have been deployed around Southern Ireland and South Wales to measure different chemical, physical and biological properties.

In Swansea, UK, two Protus systems provided by RS Hydro have been installed. These sondes contain sensors to measure temperature, conductivity, pH, dissolved oxygen, total organic carbon, turbidity, chlorophyll A and chromophore dissolved organic matter.

The sonde at the Swansea Tidal Barrage is suspended from the outer wall of the lock structure of Swansea marina and it also measures the tidal water from Bristol Channel at various depths dependent on the tide.

The 360 Aquaculture sonde measures the water within Queen's Dock which is typically an isolated body of water with no tidal variation. A series of locks can be opened allowing passage into this area from the bay however the exchange of water is small relative to the body of water. This site is of interest as it is an oyster farm.

Photographs of the Protus sondes and deployments in Swansea, South Wales, UK.

**Site 360 Aquaculture 31/07/2022 - 07/09/2022**

**Site 360 Aquaculture 31/07/2022 - 07/09/2022**

Data collected from the Protus sonde located at 360 Aquaculture in Swansea, UK between 31<sup>st</sup> July and 07<sup>th</sup> August 2022.

The left hand graph shows temperature in °C and conductivity in dS/m. The sharp drop on the 16<sup>th</sup> August was a result of rainfall after an extended dry period.

The right hand graph shows pH and dissolved oxygen data collected over the same period.

Observed Weather in Swansea, August 2022 from @WeatherSpark.com

In addition to the deployed Protus sondes, the project research team are developing new low cost sensors and monitoring systems. Researchers in Swansea University in the Welsh Centre for Printing and Coating are looking at advanced printing and coating technologies to fabricate temperature, conductivity, pH and dissolved oxygen sensors with support from the Centre for Sustainable Aquatic Research (CSAR) who will be testing the sensor technologies in a controlled recirculating aquaculture system before trial deployment.

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Tim Mortensen (WCPC) kindly brought several prototype STREAM developed sensors units along with a mock-up of a 2D printed sensor for those attending the CSAR event to see.





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