



Welcome to the STREAM workshop

11th May 2022



SETU

"STREAM is part-funded by the ERDF through the Ireland Wales Programme"





STREAM: Development of new instruments and platforms for cross-border marine observation and ecosystem monitoring that increase the number of parameters that can be measured automatically, lowering the costs of observation and accelerating the dissemination of data to Coastal Communities and Stakeholders.

SETU (some key members – last six months)

Dr Joseph O'Mahony (PI)

John Ronan

Benyuan Yu

Mitra Abedini

Hugh O'Sullivan

An overview of STREAM



Swansea University
Munster Technical University
Waterford Institute
Technology (South East
Technological University)



Three key objectives:

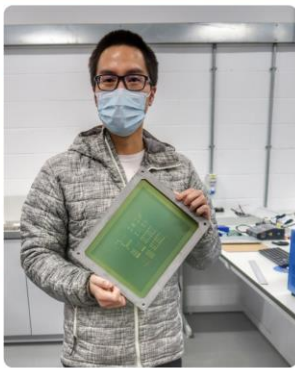
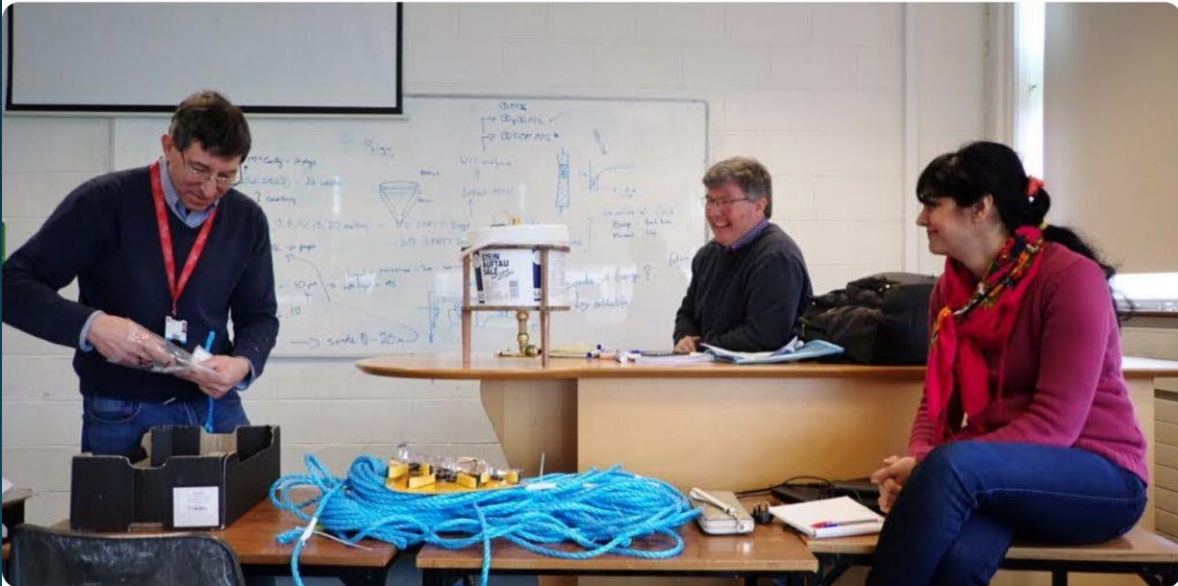
- 1) Develop and deploy sensors – generating real time data
- 2) Biological findings/ models
- 3) Workshop and dissemination (Stakeholders)



John Ronan - Hugh O'Sullivan – Joe O' Mahony (WIT)



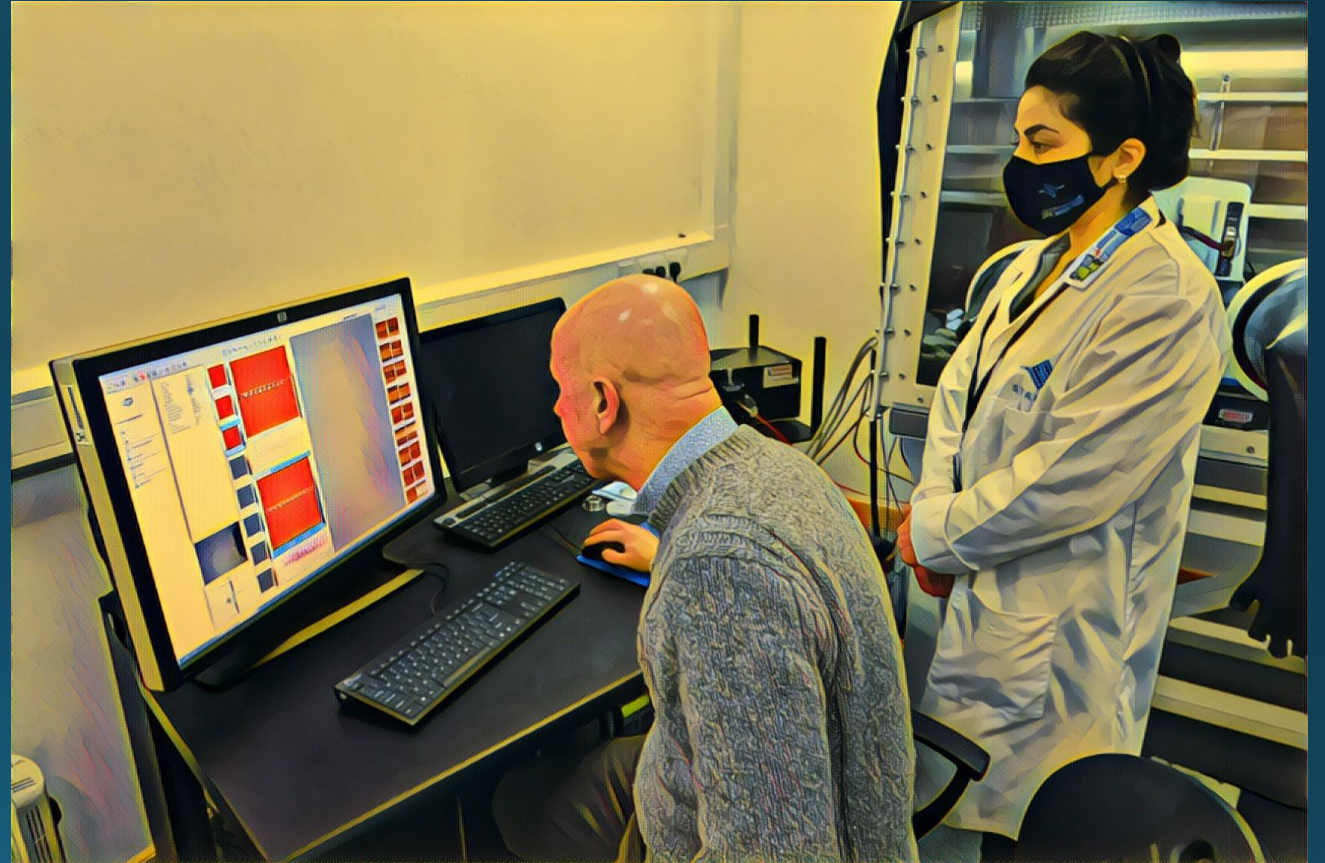
MTU and SU (WCPC and CSAR) STREAM Teams (wide skill set and experience)



STREAM

Work packages

- 1: Management and Governance
- 2: Specification
- 3: Dissemination
- 4: Development of ICT enabled Sensor Technologies for Estuarine Monitoring
- 5: Estuary Water Sampling & Precipitation Monitoring
- 6: STREAM Deployment
- 7: Building capacity to respond to climate change impacts on the Irish Sea



Dr. Mitra Abedini was employed as a Post Doc Researcher studying bio-toxins, September 2021. She has been working on the development of ICT enabled sensor technologies.



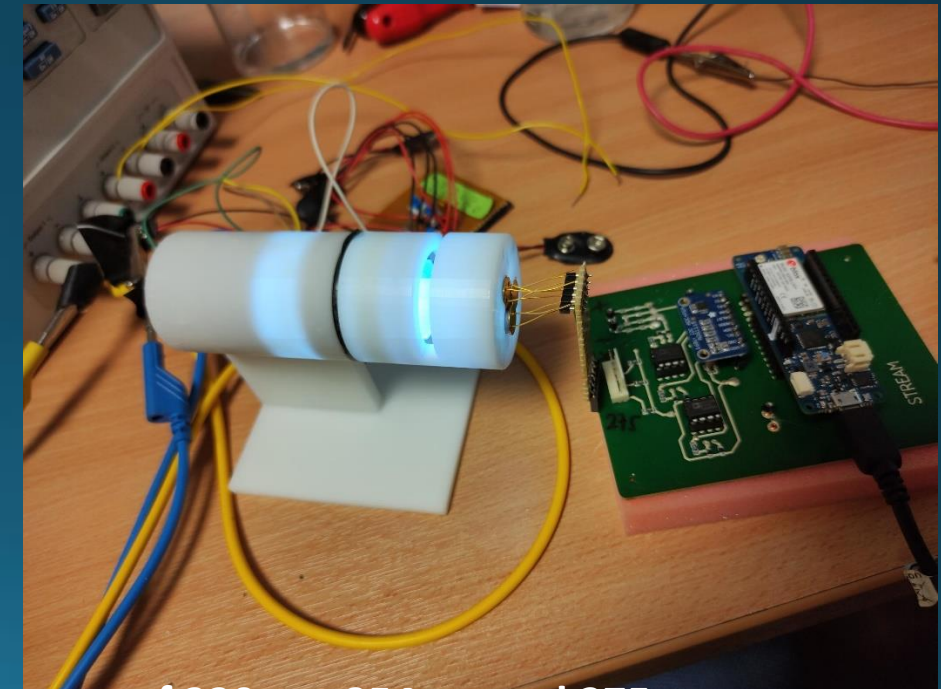
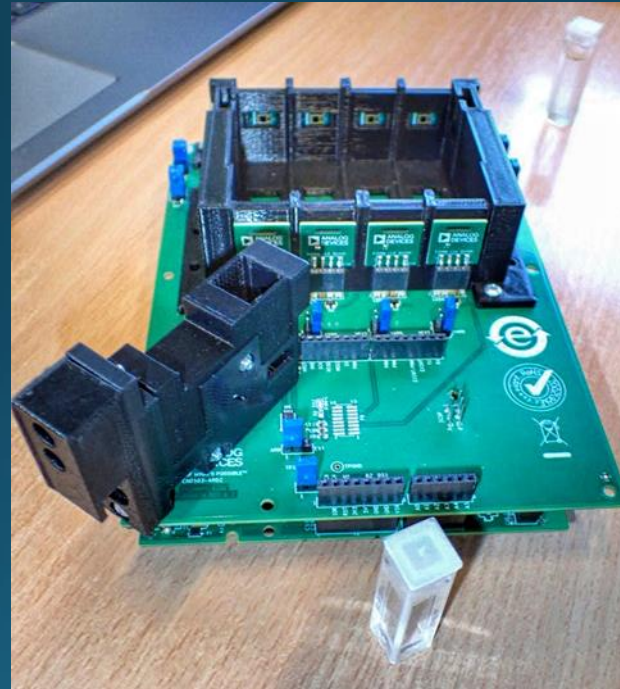
WIT work

Benyuan Yu

Work is ongoing to develop a systems that includes optical **UV spectrometer and multiple narrow spectra response** photodiodes with the function of remotely controlling and transferring data onto terminal for multiple compositional analysis.

A triplicated HAMAMATSU silica photodiode-based system has been made for detecting **Nitrate NO₃⁻ at 220nm, Dissolved organic carbon (DOC) at 254nm**, and reference detection for all other ions contents subtraction at 275nm.

A prototype has been made and calibrated and has been tested at marine sampling sites in Co. Waterford.



Benyuan Yu Prototype of 220nm, 254nm and 275nm photodiodes for the optical Nitrate, Organic Carbon measuring system.



Climate Change

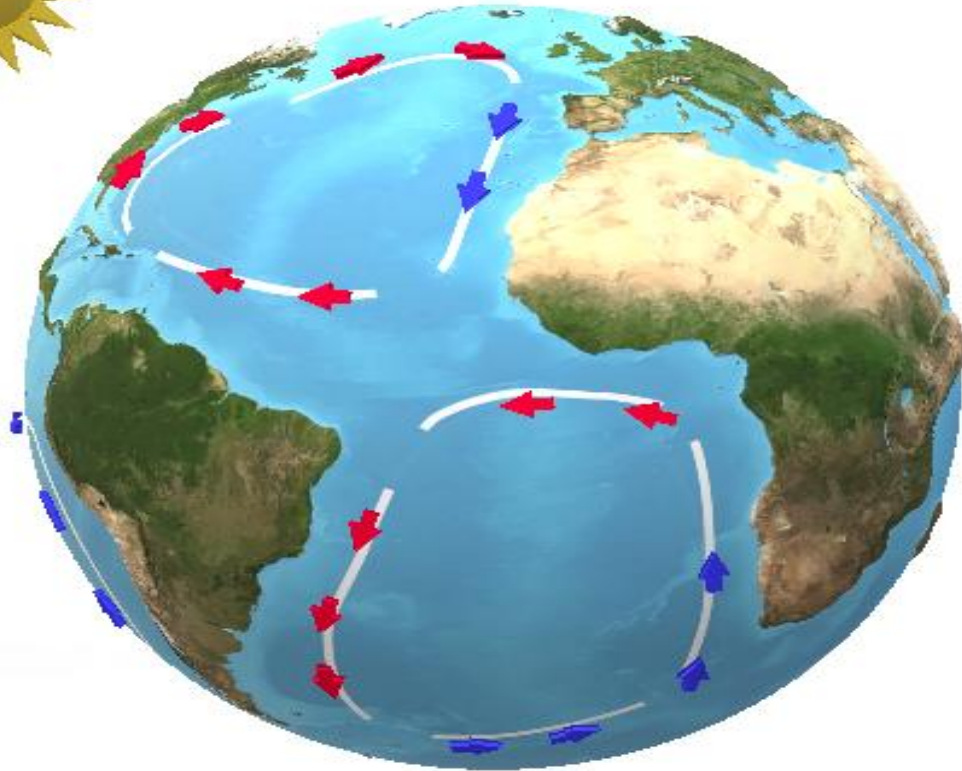
There is much media attention on global warming, focusing on our heating atmosphere and seas leading to extreme weather events, decreasing ice cover and rising sea levels.

These environmental changes also alter seawaters fundamentals (physicochemical properties) and lead to a less predictable or more chaotic natural environment where biological interactions are less certain and will potentially profoundly affect our world.

A big **issue with climate change is its unpredictability.**



Climate Change



Selected observed climate change impacts Ireland.

There has been an increase of about 0.8°C since 1900, an average of 0.07°C per decade (Dwyer, 2012).

The number of warm days has increased, and frost days reduced (Dwyer, 2012) (Met Eireann 2021).

Annual national average rainfall has risen by almost 60 mm or 5% between 1981 to 2010, contrasted to 1961 to 1990 (Dwyer, 2012)(Met Eireann 2021).

Sea surface average temperature at Malin Head is more than 1.0°C higher now than the long-term average calculated for 1961 to 1990 as cited in Dwyer, 2012.

Sub-surface and deep offshore waters around Ireland between 1991 and 2010 exhibited a significant increase in acidity. Surface ocean acidity around the world increased by over 30% from the Industrial Revolution.

Sea level has risen at 1.7cm per decade since 1916, measured at Newlyn in England. Measurements that are thought to be representative of the situation to the south of Ireland.

The river flows measured around the country have shown a tendency for increasing annual mean flows.

Ireland's National Phenology Network (IE-NPN) have recorded the timing of budburst for several tree species. Indications are that there is much year-to-year variation in the data. Still, for example, the overall trend was that for *Fagus sylvatica* (beech), leaf unfolding occurs nearly three weeks earlier in 2008 than in the 1970s. (Donnelly et al., 2013).

Research has shown that the impacts of climate change are already evident in Irish marine waters, with the patterns of harmful algal blooms changing in recent decades (Marine Institute, 2021) .

Studies show that marine species diseases are spreading and increasing. Warming waters can expand infectious agents ranges and result in diseases where they were previously unknown.



**SE
TU**

Ollscoil
Teicneolaíochta
an Oirdheiscirt
South East
Technological
University



**Swansea
University**
Prifysgol
Abertawe



MTU
Ollscoil Teicneolaíochta na Mumhan
Munster Technological University



STREAM is part funded by the ERDF through the Irelnd Wales programme



What is STREAM about?



Sensor Development

Marine and Meteorological monitoring (With Stakeholders)



Data Collection



Assessment of the environment



Change Detection and Early Warning

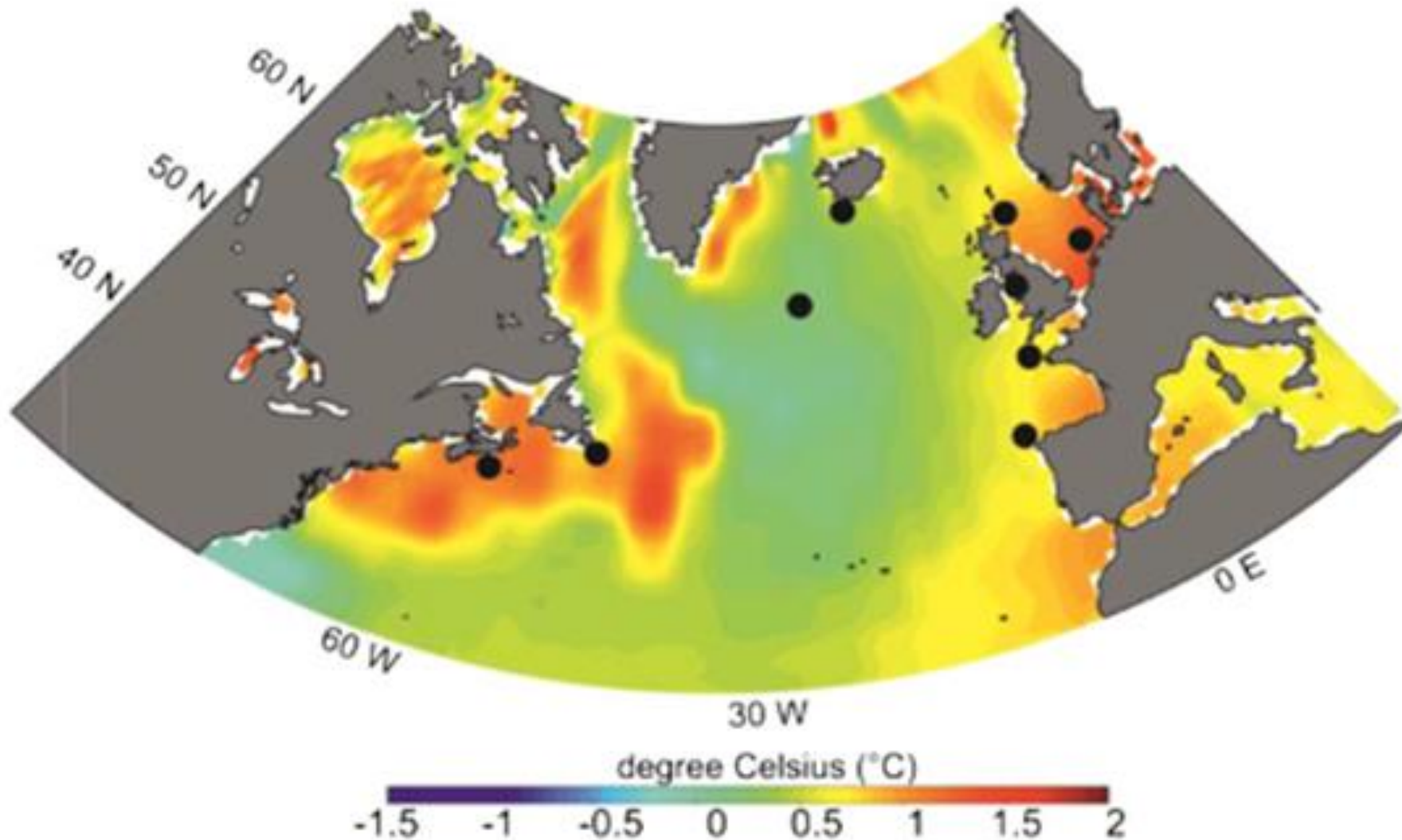


Modelling - Risk planning –
Visualisation

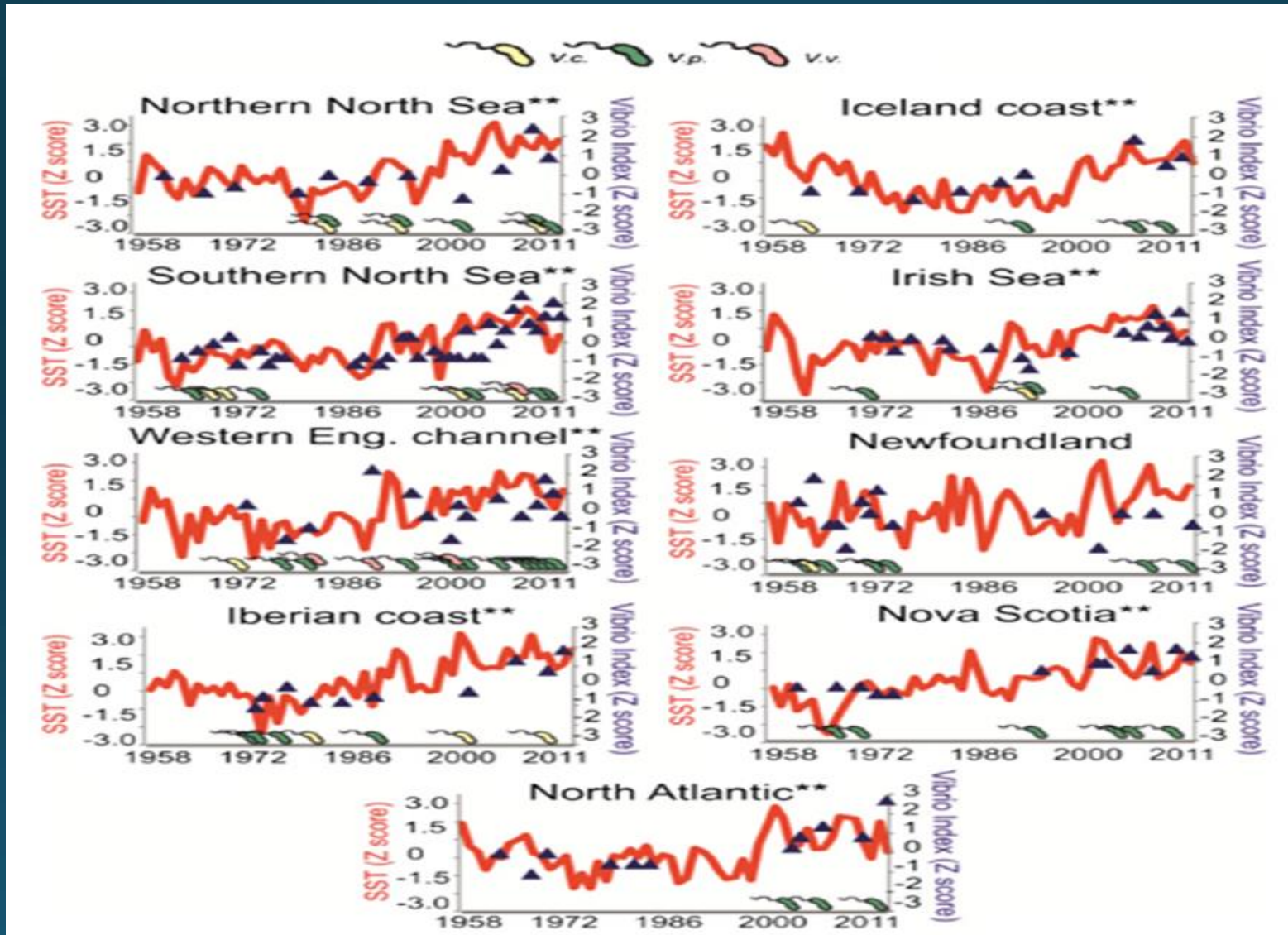


Adaptive Design – Community Resilience (Stakeholders)

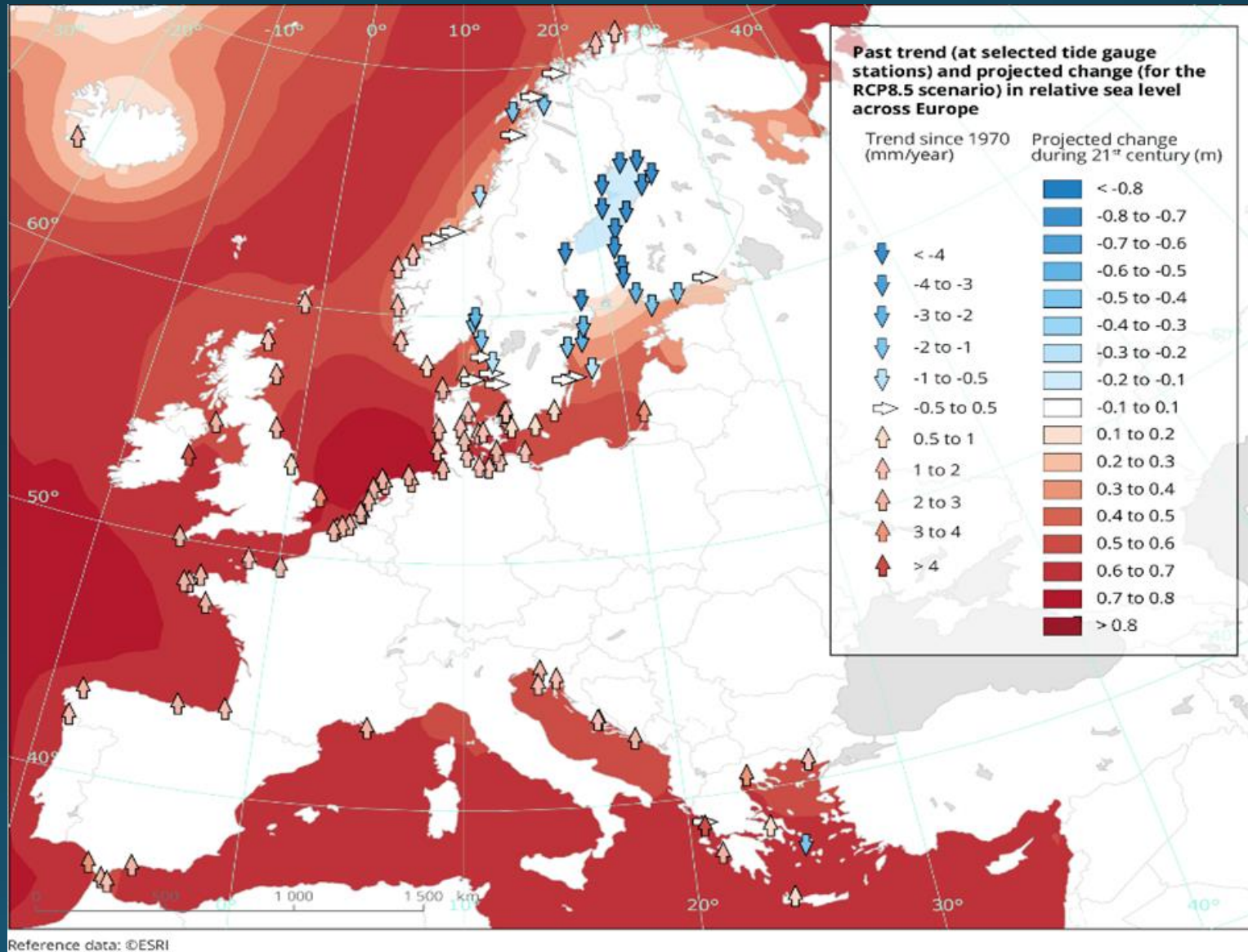
Changes in the North Atlantic Sea Surface Temperature (SST °C) between 2000-2011 and 1890-1958. The **red/orange/yellow** colours show warming, **green** stability, and **blue** cooling. The areas sampled for *Vibrio* bacteria are depicted by black dots (Vezzulli et al., 2016).



The relationship (1958 to 2011) between *Vibrio* bacterial abundance (blue triangles) and surface sea temperatures (red line) in the North Atlantic (Vezzulli et al., 2016).



Changes in European sea levels as provided in EEA, 2021.

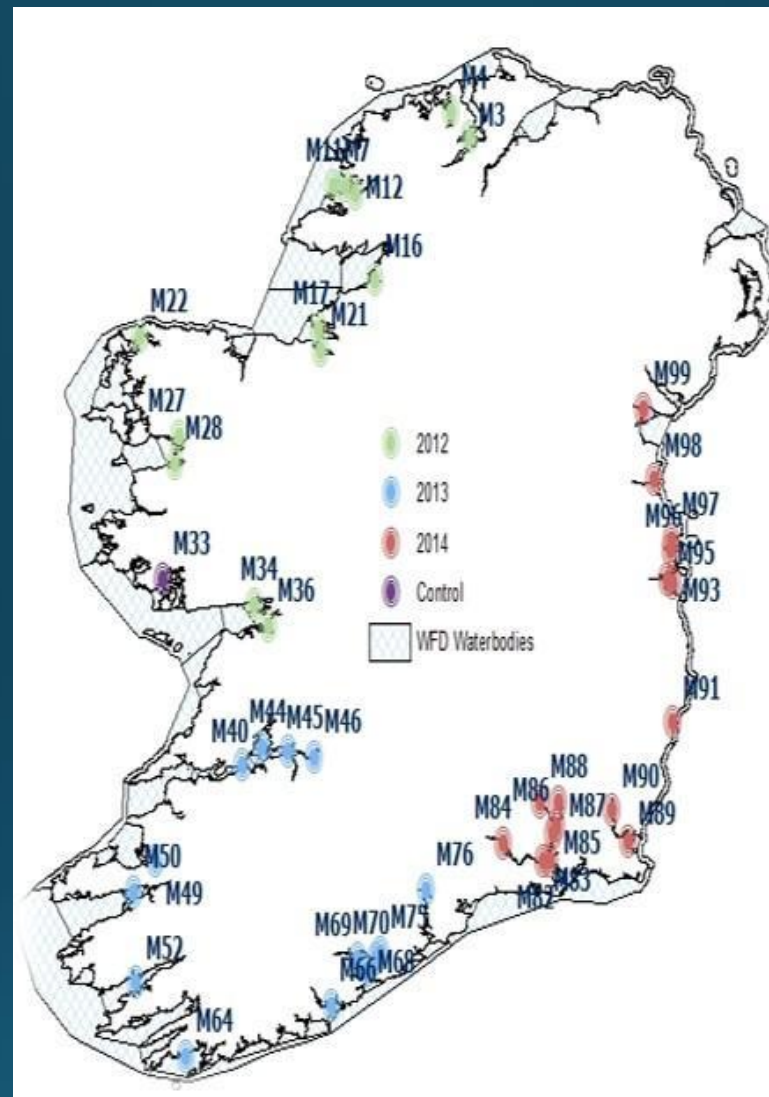


Sampling Examples:

Currently there is a lot of high quality spot or single sampling events occurring around the country (EPA, MI, Co. Co. etc.).

STREAM offers the potential for a network of continual monitoring – but the quality of data will only as good as the calibrations.

Continual monitoring provides real time information on change.



EPA Lakes and Rivers WFD

Marine Inst. / EPA
WFD and Co. Co.



SETU Telemetry – broadcasting of live data



SETU STREAM have developed a portable battery powered telemetry system that can be used to broadcast live Sensor/ SONDE data. The advantage of the unit is the ability to broadcast from remote locations where there is no power.



Deployments – Wexford Co. Co.

Two SONDE's were deployed in Wexford in association with Wexford Co. Co. in January 2022. These SONDE's were an EXO2 and Trious Opus which are now broadcasting live data and it is planned in the near future to set up a weather station in the area.

Wexford Co. Co. have established a power and telemetry box along with a partial pipe support for SONDE's in Wellington Bridge to monitor



Exo2 – Depth, temp, conductivity (Salinity), oxygen, turbidity, chlorophyll and fDOM
Trious opus -



MTU

MTU in association with SETU have temporarily deployed an EXO2 from a BIM dive training Barge and established a weather station in Castletownbere (2/2/22). A preliminary SOP for sampling and calibrations has been written along with the establishment of field recording sheets.



RB

Dr. Naghmeh Kamali, Dr. Ambrose Furey and Paul Shanahan (MTU)

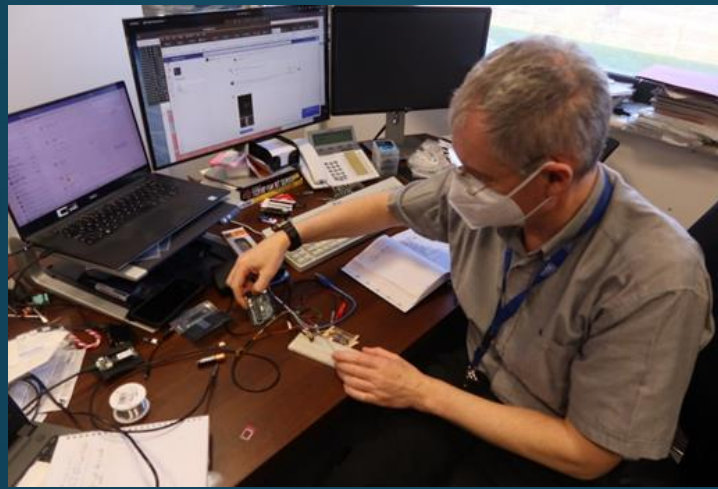


Arduino - Sensors

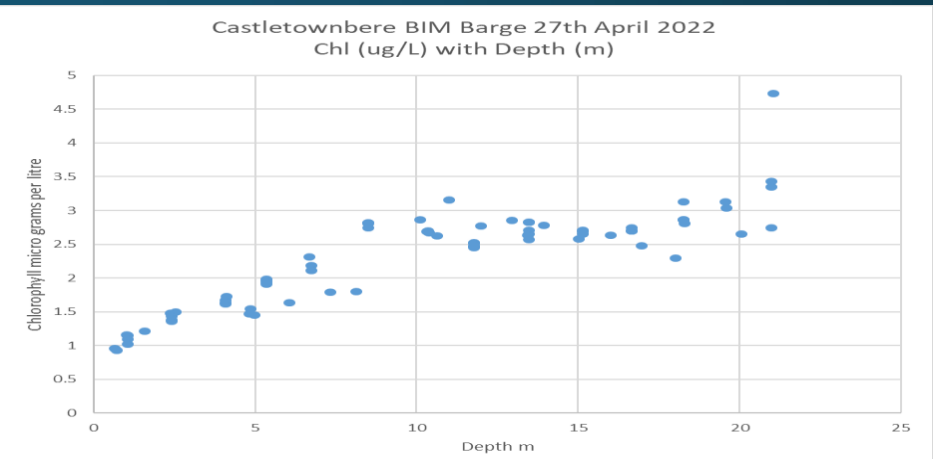
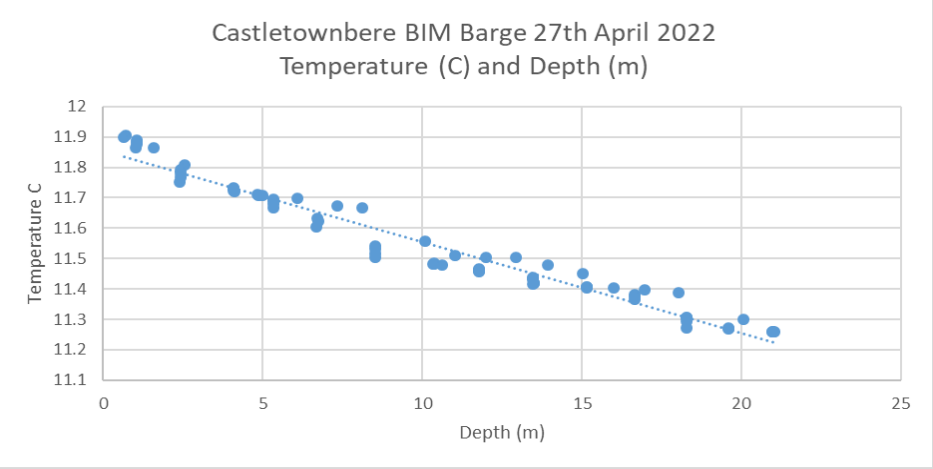
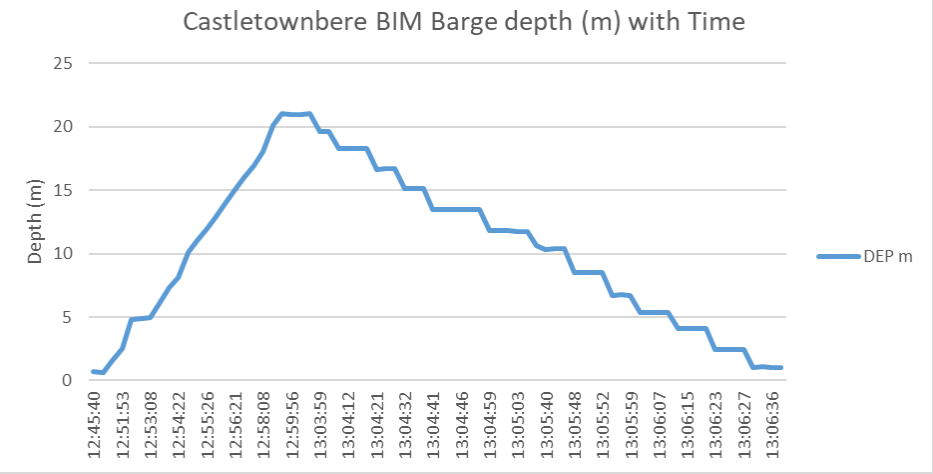
Work has progressed on the development of a thermistor string (daisy chain of sensors) at ArcLabs. The software for the probes has been written and the sensor components waterproofed and calibrated.

SETU worked on constructing a variety of low cost sensors using Arduino technology. The design and construction of these modular sensor units is accessible for interested stakeholders such as aquaculture operations or environmental scientists investigating climate change impacts.

It is our intention to run workshops that will teach and train the construction techniques and explain the significance of the physiological measurements that are being taken.



John Ronan working on a thermistor string (temperature sensors daisy chained along the length of a 20 m cable)



Weather Stations

Temperature

Wind speed and direction

Rainfall

Humidity

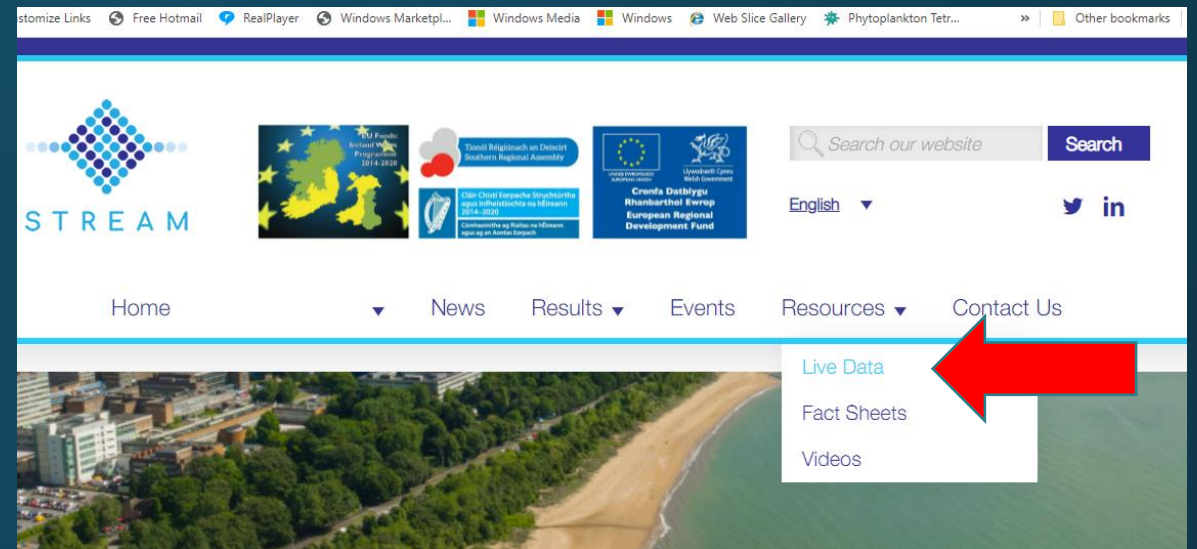


Weather Stations and Live Data marinestream.eu

Castletownbere, Tramore and Faha (Dungarvan) Weather Stations are in operation and broadcasting live data.

Novel software (Joe O'Mahony) is being developed by WIT to analyse the data being collected from STREAM deployed sensors, remove electronic anomalies and test for correlations between physiochemical, nutrient and chlorophyll recorded.

Data is now being broadcast from Dunmore East, Waterford City Weather and Water Sensor, Wexford Harbour (Exo2 and Trious Ópus), Dungarvan Weather, and Castletownbere – see https://www.marinestream.eu/live_data/



Dunmore East Sea Surface Temperature

Sea surface temperature
Dunmore East, co. Waterford,
Ireland.



Waterford City River Suir Surface Temperature

The water surface temperature on
the Suir River, Waterford City,
Ireland.



Wexford Harbour Environmental Sensors

Environmental parameters from a
YSI EXO 2 and TriOS OPUS in
Wexford Harbour, Ireland.



STREAM Project Water Quality Monitoring

When assessing water quality, different parameters such as chemical, physical, and biological properties can be tested to evaluate the status of a waterbody. The STREAM project is developing sensors and monitoring for changes in temperature, dissolved oxygen, salinity (conductivity), pH, turbidity, chlorophyll, and nutrients.

- **Temperature (OC):** is a critical factor that affects biological life as it impacts lifecycle and growth. Warmer waters also contain less dissolved oxygen than cool water, which can affect the survival and distribution of aquatic organisms. The water temperature regulates the rates of biological and chemical reactions, making some compounds may be more toxic at higher temperatures.
- **Dissolved oxygen (%):** Marine plants, such as the microscopic phytoplankton and seaweeds, convert carbon dioxide into sugars and oxygen by photosynthesis. They produce over half of the oxygen in our atmosphere. While marine animals require dissolved oxygen through diffusion into their body tissue or gills.
- **Salinity (PSU):** The salt concentration in seawater is measured in Practical Salinity Units (PSU). Around Ireland, in offshore waters, the salinity may reach levels approaching 35 PSU. In contrast, in estuaries, the levels may reduce to close to zero when there is a lot of freshwater inputs. The salinity affects the distribution of many plants and animals.
- **pH (0 to 14 scale):** This measures how acid or alkaline the seawater is in coastal waters such as an estuary. This is strongly influenced by the area's geology, the river's source flows and biological activity.
- **Turbidity (NTU):** Measures how clear or cloudy the seawater is. The clarity is affected by the amount of sediment silt particles and tiny marine organisms in the water column.
- **Chlorophyll ($\mu\text{g/L}$):** Seawater contains microscopic organisms called phytoplankton and fragments of aquatic plants that use pigments such as chlorophyll-a to convert carbon dioxide into sugars and oxygen. By measuring chlorophyll, we can estimate these plants' biomass (amount), which tend to vary seasonally and follow nutrient levels in the water.
- **Nutrients** – A vital property of seawater is the concentration of dissolved nutrients as they significantly influence the health of a waterbody and stimulate primary production by phytoplankton. The concentration of nutrients is measured by optical cells and a spectrophotometer tuned to defined wavelengths for nitrogen and phosphorous compounds.



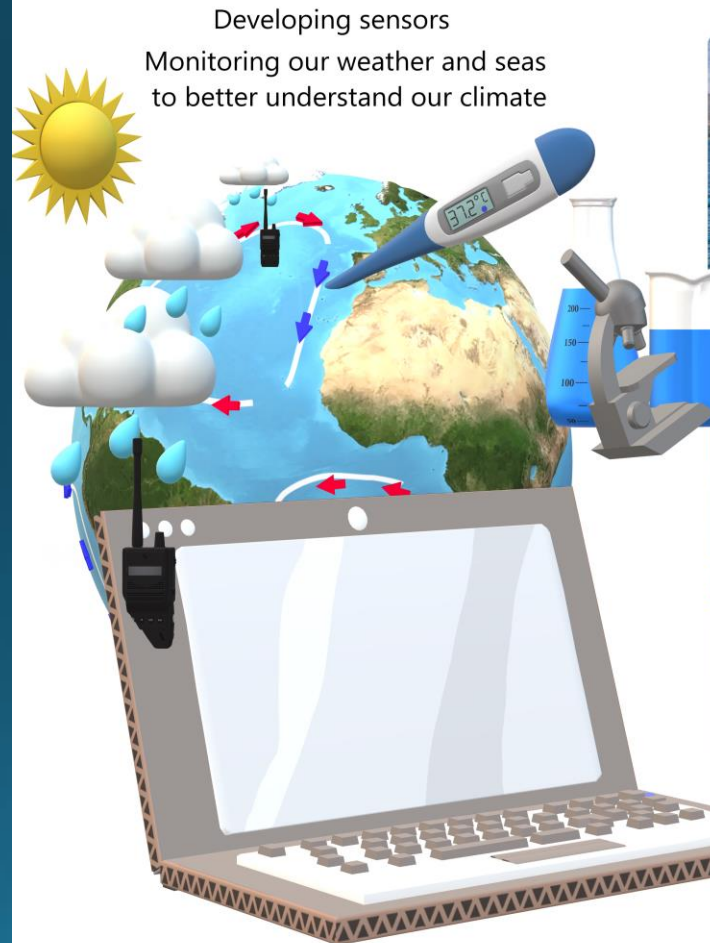
- fDOM_RFU: Fluorescent Dissolved Organic Matter that has been measured in Relative Fluorescent Units.
- fDOM_QSU: Fluorescent Dissolved Organic Matter that has been measured in Quinine Sulphate Units.
- Chlorophyll_ugl: Chlorophyll measured in micrograms per litre.
- Chlorophyll_RFU: Relative Fluorescent Units.
- BGAPe_ugl: Blue-Green Algae Phyco Erythrin (photosynthetic pigment associated with Marine Phytoplankton) measured in micrograms per litre.
- BGAPe_RFU: Blue-Green Algae Phyco Erythrin measured in Relative Fluorescent Units.
- NNO₃_mgl: Complete Nitrogen – Nitrate in milligrams per litre.
- NNO₂_mgl: Complete Nitrogen – Nitrite in milligrams per litre.
- TSSOeq: Total Suspended Solids as an equivalent. Parameters with the eq prefix are associated with the TriOS OPUS spectrometer, the company has developed a library of absorption spectra associated with the parameter.
- SAC₂₅₄_Im: Spectral Absorption Coefficient at 254 nano metres, measures the dissolved organic material that absorbs UV light at a wavelength of 254 nm. Its usually used to monitor diffuse and point source pollution in water bodies.
- Abs₃₆₀_AU: Light absorption at 360 nm measured in Absorbance Units.*
- ABS₂₁₀_AU: Light absorption at 210 nm measured in Absorbance Units.*
- ABS₂₅₄_AU: Light absorption at 254 nm measured in Absorbance Units.*
- NO₃_mgl: measures the Nitrate in the water in milligrams per litre.



STREAM - Sensor technologies for remote aquatic monitoring



STREAM is part funded by the ERDF through the Ireland Wales programme



Developing sensors
Monitoring our weather and seas to better understand our climate



Data

Download – CSV. – excel files. Freely available

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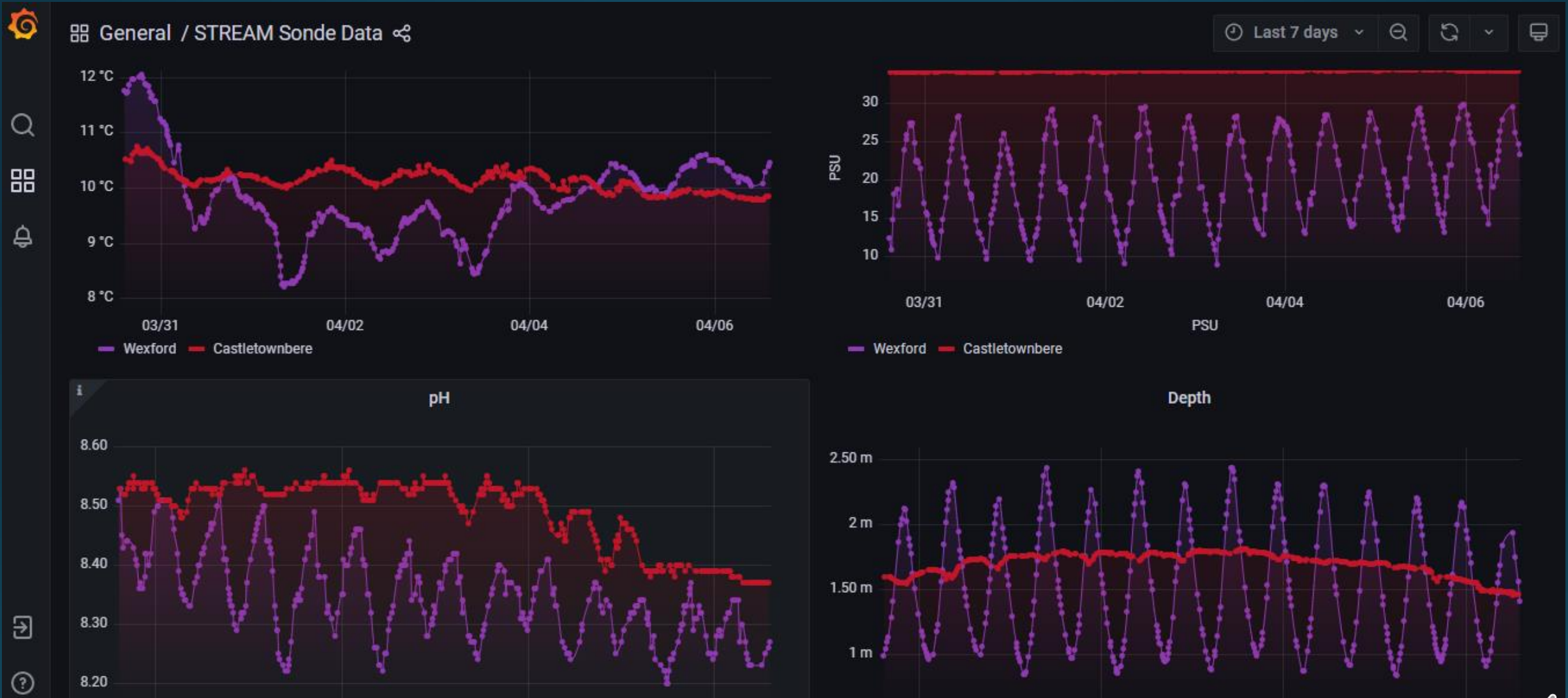
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..			Directory
2022_02_Castletownbere.csv	2022-Mar-21 17:04:49	331.9K	text/csv; charset=utf-8
2022_02_Mexford_Harbour.csv	2022-Mar-21 17:09:19	709.4K	text/csv; charset=utf-8

2022_02_Castletownbere (5) - Excel

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	Date	Time	Temperat	SpConduc	Salinty_PS	Depth_m	pH	Turbidity	DO_pc	DO_mgl	fDOM_RF	fDOM_QS	Chlorophy	Chlorophy	BGAPe_ug	BGAPe_RF	Battery
2	02/02/2022	13:16:06	9.776	53117.45	34.79	1.737	8.28	0.82	99.49	9.03	0.84	1.91	-0.53	0.05	1.17	-0.53	13.04697
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6	02/02/2022	14:16:06	9.775	53124.36	34.79	1.722	8.29	0.73	99.76	9.06	0.82	1.83	-0.26	0.12	1.78	-0.3	13.04259
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8	02/02/2022	14:46:06	9.776	53172.62	34.83	1.718	8.29	0.72	99.08	8.99	0.74	1.62	-0.48	0.06	1.81	-0.29	13.04064
9	02/02/2022	15:01:06	9.769	53154.29	34.82	1.718	8.29	0.83	99.24	9.01	0.72	1.56	-0.32	0.11	2.35	-0.1	13.0382
10	02/02/2022	15:16:06	9.775	53162.2	34.82	1.713	8.29	0.74	99.24	9.01	0.72	1.55	-0.4	0.09	1.98	-0.23	13.0382
11	02/02/2022	15:31:06	9.775	53157.41	34.82	1.711	8.3	0.68	99.26	9.01	0.77	1.71	-0.2	0.14	2.61	0	13.03528
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13	02/02/2022	16:01:06	9.78	53161.79	34.82	1.707	8.3	0.73	99.35	9.02	0.78	1.72	-0.24	0.13	2.68	0.03	13.03553
14	02/02/2022	16:16:06	9.778	53161.53	34.82	1.705	8.3	0.65	99.46	9.03	0.79	1.77	-0.13	0.16	3.07	0.17	13.03869
15	02/02/2022	16:31:06	9.783	53160.34	34.82	1.706	8.3	0.66	99.51	9.03	0.8	1.78	-0.24	0.13	2.37	-0.09	13.03601
16	02/02/2022	16:46:06	9.783	53155.89	34.82	1.702	8.3	0.69	99.41	9.02	0.7	1.5	-0.21	0.14	2.95	0.13	13.03577
17	02/02/2022	17:01:06	9.779	53153.02	34.82	1.7	8.3	0.73	99.64	9.05	0.78	1.74	-0.24	0.13	2.52	-0.03	13.03309
18	02/02/2022	17:16:06	9.777	53163.93	34.82	1.7	8.31	0.72	99.7	9.05	0.79	1.75	-0.09	0.17	3.22	0.22	13.03406
19	02/02/2022	17:31:06	9.775	53159.36	34.82	1.696	8.31	0.75	99.61	9.04	0.79	1.77	-0.21	0.14	2.81	0.08	13.03017
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22	02/02/2022	18:16:06	9.769	53164.34	34.82	1.689	8.31	0.75	99.38	9.02	0.79	1.74	-0.06	0.18	3.52	0.33	13.02846

Live data (marinestream.eu)

The difference in the data is that Wexford sonde is intertidal, while Castletownbere is suspended from a barge



Acknowledgements



Wexford County Council = monitoring sites

Brendan Cooney

EPA = Data from 1992 to present

Robert Wilkes

BIM = Field Assistance

Brian O'Loan – oyster sites

Shane Begley - Weather Station and Barge (Castletownbere)

Marine Institute =

Dave Clarke

Phytoplankton data

Tramore Coast Guard

Tramore = Weather Stations

Dunmore East Harbour = Monitoring sites

Waterford City River Rescue = Monitoring sites

Southern Assembly - Breda Curran

Thank you for listening



- **Wednesday 11th May 2022**
- **Time** **Walton Institute**
- **9:30-10:00** **Introduction Dr. Ronan Browne (SETU) - Aspects of the STREAM Project.**
- **10:00-10:30** **Dr. Joe O'Mahony PI (SETU) - Optical Sensors. Development of an estuarine monitoring system for the Ireland Wales region.**
- **10:30-11:00** **Prof. David Gethin (SU - WCPC) - 2D printed sensors and their applications.**
- **11:00-11:15** **Break**
- **11:15-12:15** **Dr. Naghmeah Kamali and Dr. Ambrose Furey (MTU) - "The Application of SPATT (Solid Phase Adsorption Toxin Tracking) for the pre-concentration of biotoxin and organic compounds from marine, estuary and freshwaters."**
- **12:15-12:45** **Prof. Carlos Garcia de Leaniz / Paul Howes (SU, CSAR) - "Modelling the impacts of climate change on finfish in the Irish Sea" (online)**
- **12:45 -13:15** **Dave Clarke (Marine Institute) Monitoring for HAB's (online)**
- **13:15-14:00** **Lunch (Caterer)**
- **14:00-14:30** **Hugh O'Sullivan/ Benyuan YU and Dr Mitra Abedini (SETU) - STREAM sensors, detectors and data - A practical demonstration.**
- **14:30-15:00** **Brendan Cooney (Wex, Co. Co.). Environmental monitoring by Wexford Co. Co.**
- **15:00-15:30** **Dr. Robert Wilkes (EPA) - "Monitoring supporting parameters for the WFD in transitional and coastal waters" (online)**
- **15:30-16:00** **John Ronan (SETU) - Architecture, data and weather stations.**
- **16:00-16:15** **Break**
- **16:15-17:15** **STREAM partner meeting**

STREAM Partner Meeting this afternoon - Progress against milestones

Milestone	Task Number	Work Package Number	Due Date	Description	Related Outcome	Owner, PM at indicted Site	Beneficiaries	Comment
1	T1.1	1	M9	Establishment of all Management Structures	Operation Management	WIT	Internal	Complete
2	T1.2	1	M9,15,16,21	Staff Recruitment	Operation Implementation	All	Internal	Underway due for M21
3	T1.3	1	M9	Communication Management	Improved Dissemination & Knowledge Transfer between the different regions	WIT	Internal & Coastal Communities	Complete and issued to WEFO, Being updated as project progresses
4	T1.4	1	M13	Data Management	Knowledge dissemination and data retention.	WIT	Internal, Coastal Communities and Future Generations	Requires updating to take account of new procedures at partner sites
5	T1.5	1	M14	Quality Assurance Manual	Operation Implementation	WIT	Internal	Currently Outstanding, due for next Reporting Period.
6	T1.8	1	M0, 6, 12, 18, 24, 30, 36, 42, 48	Submission of Financial Reports to Funding Body	Operation Implementation	WIT	Internal	Ongoing
7	T2.1	2	M11	Final Specification of STREAM monitoring sites	Operation Implementation	WIT	Coastal Communities and	Stage 1 complete, SU and CIT are



RB

STREAM



Tionól Réigiúnach an Deiscirt
Southern Regional Assembly



Clár Chistí Eorpacha Struchtúrtha
agus Infheistíochta na hÉireann
2014-2020

Cómhaoinithe ag Rialtas na hÉireann
agus ag an Aontas Eorpach



LINDIS EWROPEAID
EUROPEAN UNION



Llywodraeth Cymru
Welsh Government

Cronfa Datblygu
Rhanbarthol Ewrop
European Regional
Development Fund



Clár Na hÉireann - Na Breataine Bige 2014-2020

Rhaglen Iwerddon Cymru 2014-2020

Ireland Wales Programme 2014-2020

**Cronfa Datblygu
Rhanbarthol Ewrop**
**European Regional
Development Fund**



Tionól Réigiúnach an Deiscirt
Southern Regional Assembly



**Ireland's European Structural and
Investment Funds Programmes
2014-2020**

**Co-funded by the Irish Government
and the European Union**