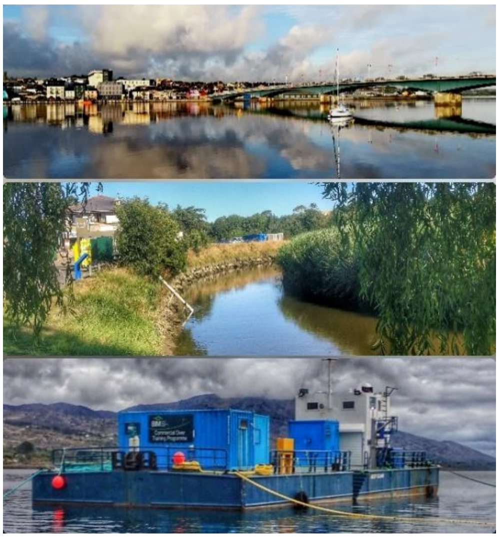
STREAM



Sensor technologies for remote environmental aquatic monitoring (STREAM).

This meeting was a practical hands-on workshop for stakeholders concerned about climate change's impacts and who wish to establish monitoring systems to better understand the changing environment.

The venue for this meeting is:

Wexford County Council

Wexford County Council, Carricklawn, Wexford, Y35 WY93

Friday 16th December 2022

The STREAM project's objectives are to help improve the monitoring of our environment by increasing remote sensor availability and data resources.

This workshop worked on explaining the fundamentals of aquatic and meteorological sensors. To demonstrate their operation and explain the environmental implications of the readings.

Typically the quality of a water body is based on spot sampling, whereby water samples are collected and then brought to a laboratory for analysis. This strategy typically provides a high-quality assessment of a moment in time. Unfortunately, collecting and analysing water samples can be time-consuming and costly. While a field-based monitoring system with telemetry, with remote sensors that are well-managed and appropriately calibrated instruments, provides real-time information to many stakeholders on the trends and changes in water quality continuously.

The Schedule for Friday 16th December was:

10:00 The STREAM project, climate and why measure environmental parameters an introduction (Dr Joe O'Mahony – Dr Ronan Browne).

11:00 Tea break:

11:00 (SETU and SU) Dr. Joseph O'Mahony (PI STREAM Project), Benyuan Yu and Ronan Browne.

Sensor(s) and their operation – this session will include hands-on demonstrations and technical descriptions.

(A) Aquatic

1. Temperature
2. Salinity (Conductivity)
3. pH
4. Oxygen
5. Chlorophyll
6. Nutrients
7. HABs

(B) Meteorological (John Ronan SETU)

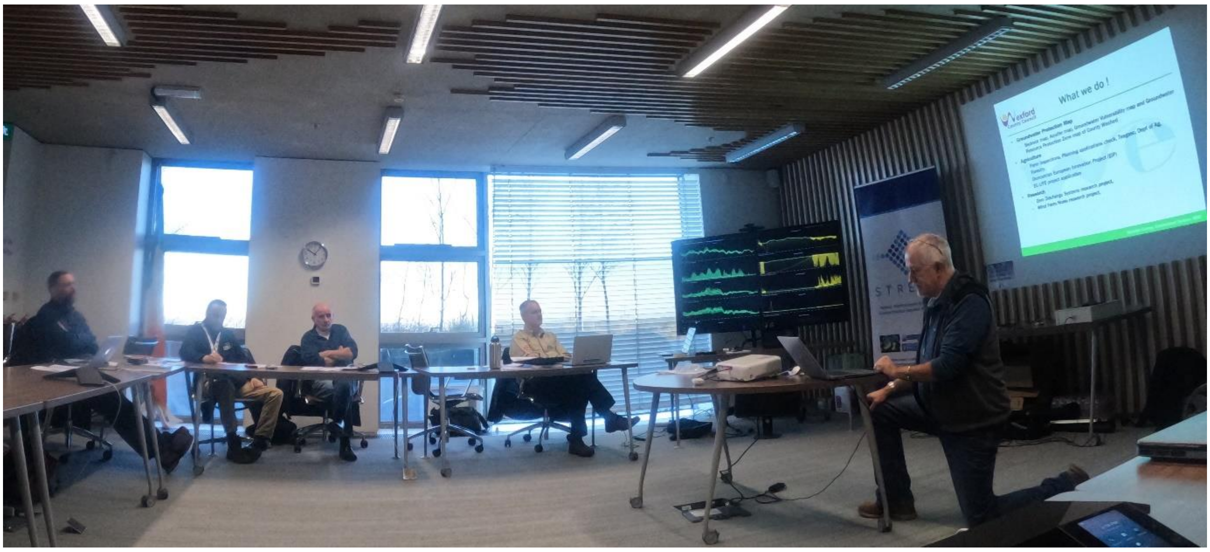
1. Temperature
2. Precipitation

3. Humidity
4. Wind speed
5. Wind direction
6. Forecasting

(C) Technology for transmitting live data and managing the information collected.

13:00 Lunch, please get in touch with ailish.tierney@setu.ie if you will be attending

Wexford County Council 14:00 to 14:25 Brendan Cooney – environmental monitoring in the county



Following the presentations and demonstrations there was a discussion on the needs of the stakeholders and the requirement of pertinent information that they could supply to help relate their observations to the various parameters the STREANM project is measuring.

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

Below is some of the information provided by the STREAM project TEAM:

STREAM December 16th Wexford Co. Co.

The STREAM project is developing sensors and monitoring for changes in water and weather to better assess the impacts of annual variability and climate change.

When assessing water quality, different parameters such as chemical, physical, and biological properties can be tested to evaluate the status of a water body. The STREAM project investigates water temperature, dissolved oxygen, salinity (conductivity), pH, turbidity, chlorophyll, biotoxins, and nutrients.

These parameters include:

Temperature (^{O}C): 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 (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.
- NNO_3_mgl: Complete Nitrogen – Nitrate in milligrams per litre.
- NNO_2_mgl: Complete Nitrogen – Nitrite in milligrams per litre.
- TSSQeq: 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_lm: Spectral Absorption Coefficient at 254 nano metres, measures the dissolved organic material that absorbs UV light at a wavelength of 254 nm. It is 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.

Table A. Some observed climate change impacts in 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 with 1961 to 1990 (Dwyer, 2012)(Met Eireann 2021).
Sea surface average temperature at Malin Head is more than 1.0°C higher than the long-term average calculated from 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 worldwide increased by over 30% from the Industrial Revolution (Ni Longphuirt et al. 2010).
Sea level has risen at 1.7cm per decade since 1916, measured at Newlyn in England. These measurements may represent the situation to the south of Ireland (Dwyer 2021) though the sea-level rise is variable and somewhat dependent on isostatic changes.
The river flows measured around the country tend to increase annual mean flows (Murphy et al., 2013).
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 occurred 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).

Table B. Selected projected climate Impacts for Ireland (with selected sources).

Mean annual temperatures will increase by 0.90 to 1.7°C; the most significant increases will be in the country's east (DCCAE, 2018). The climate will continue to warm, particularly in the summer and autumn seasons (Dunne et al., 2008).
Warm days (defined as the highest 5% of maximum daily summer temperature) will get warmer by 0.7 to 2.6°C compared with the baseline period (DCCAE, 2018).
Cold nights (defined as the bottom 5% of minimum daily winter temperature) will get warmer by 1.1 to 3.1°C (DCCAE, 2018).
The average number of frost days (defined as a day when the minimum temperature is less than 0°C) is expected to decrease by over 50% (DCCAE, 2018).
The typical length of the terrestrial growing season will increase (Donnelly et al., 2013)(Nolan, 2015).
There are projected decreases in mean spring and summer precipitation, the largest for summer, with reductions ranging from 0% to 20% by mid-century (DCCAE, 2018). The autumn and winter will become wetter, with heavy rainfall events increasing in winter, with overall increases of 15 to 25% towards the end of the century (Dunne et al., 2008) (Nolan, 2015).
The energy content of the wind is projected to decrease during spring, summer, and autumn. The projected decreases are most significant for summer, ranging from 3% to 15% (Nolan, 2015). There is likely to be an overall reduction in mean wind strengths towards the end of the century, particularly over the summer (4 to 5%) (Dunne et al., 2008).
The incidence of intense cyclones affecting Ireland is likely to rise (Dunne et al., 2008).
There will be a decrease in the frequency of storms affecting Ireland but an increase in intensity, with an increased risk of harm (Nolan, 2015).

A possible intensification of the hydrological cycle, leading to an increased incidence of high river and low flow periods. However, Murphy et al., 2013 note that it is challenging to discern anthropogenic climate change signals due to large inter-annual variability.
Lowe et al. 2009 report gives projections of UK coastal absolute sea-level rise (not including the land movement) for 2095, ranging from approximately 12 to 76 cm.
Around the UK, seas are projected to be 1.5 to 4 ^{o}C warmer, depending on location, and ~0.2 practical salinity units (p.s.u.) fresher by the end of the 21st century. Changing salinity depends on the projected storm tracks owing to the latter's effect on precipitation (Lowe JA, 2009).
Around Ireland, the seas have been warming at the rate of 0.3 to 0.4 ^{o}C per decade since the 1980s and the greatest warming has been observed over the Irish sea of 0.6 to 0.7 ^{o}C per decade (Dunne et al., 2008).
Modelling results indicate an increase in the frequency of storm surge events around Irish coastal areas (Dunne et al., 2008).
Seasonal stratification strength is expected to increase in the seas but not as much as in the open ocean (Lowe JA, 2009).
Changes in mean sea level are the primary driver in magnifying the impacts of changing storm surges and wave patterns in coastal areas. (Desmond et al., 2017).
Mean sea-level rise and changes in storm surges have been combined to produce changes in extreme water levels (Lowe JA, 2009).

Table C. Some of the risks and challenges facing Ireland.

Climate change is expected to have impacts on biodiversity and increase existing pressures.
Increasing temperatures will impact phenology (the timing of lifecycle events) and species' geographical range.
Shifts in climate, temperature, and precipitation may increase invasive species and competitive pressures for Ireland's native species.
Erosion and flooding pose a severe risk to Ireland's coastal areas.
Climate change may impede the ozone layer recovery giving negative consequences due to greater exposure to UV radiation (Dunne et al., 2008).
Physicochemical changes in the marine environment will have implications for the Marine and Fisheries sector, particularly with their ranges (decrease in northerly and increase in southerly).
Warmer waters sustain lower levels of dissolved oxygen and provide favourable conditions for the growth of individual species.
Climate change will pose risks to freshwater management, exacerbating existing supply, quality, and flooding pressures.
For summer and autumn, there are projected decreases in surface water flow.
Any increase in extreme events will have significant risks of physical injuries and damage to infrastructure.
Marine Institute research indicates that the ocean off southwest Ireland will likely become warmer and less salty by the year 2035 (Marine Institute, 2021)

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