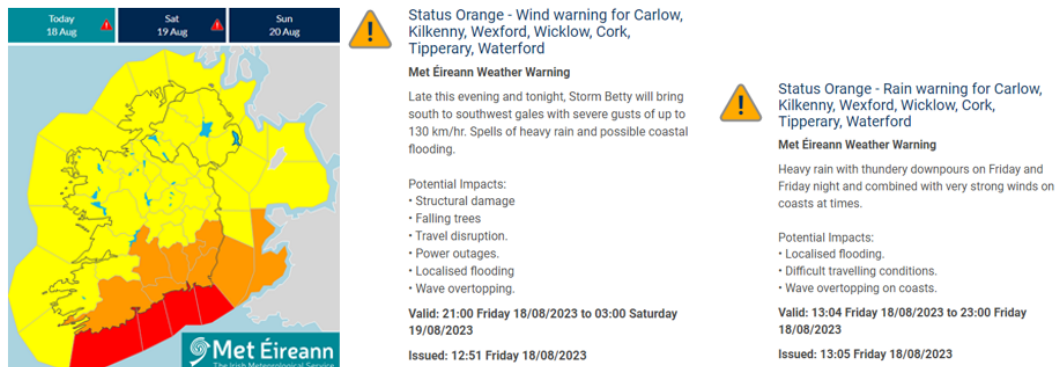




Report Card 4. Storm Betty Impacted Ireland Friday 18th August 2023 and these are some of the STREAM sensor observations



Storm Betty was a named storm that impacted Ireland on Friday, August 18, 2023. The storm brought strong winds and heavy rain, causing widespread disruption and damage.

The Irish meteorological service, Met Éireann, at the time issued a Status Orange wind warning covering a substantial portion of the country, where the potential for severe gusts reaching speeds of up to 130 km/h (81 mph) exists. This warning specifically encompassed counties Cork, Waterford, Tipperary, Wexford, Kilkenny, Carlow, and Wicklow. Concurrently, a Status Yellow wind warning was also issued for the remaining regions, as conveyed by Meteorologist Paul Downes of Met Éireann.

The ramifications of Storm Betty were substantial, resulting in widespread power outages, flooding, and disruptions to traffic. Roads across the nation bore the brunt of fallen trees, branches, and debris. Additionally, the storm led to other travel disturbances, including flight and ferry cancellations. While the worst storm subsided by Saturday morning, residual effects, such as ongoing power outages and flooding, persisted. Notably, despite the significant impact of Storm Betty, no reports of serious injuries or fatalities emerged.

The Irish government had called upon citizens to remain vigilant to the perils posed by severe weather and advised taking suitable precautions. Here are some safety tips provided by them for navigating stormy conditions:

- Stay indoors if possible.
- If you must go outside, be aware of your surroundings and take precautions to avoid falling trees or power lines.
- Secure loose objects around your property that could be blown away by the wind.
- If you are driving, be extra careful and avoid driving through flooded areas.
- Listen to local radio or television for updates on the storm.





STREAM and storm Betty

STREAM Water Quality Sensors tracked the impact on the weather and changing water quality.

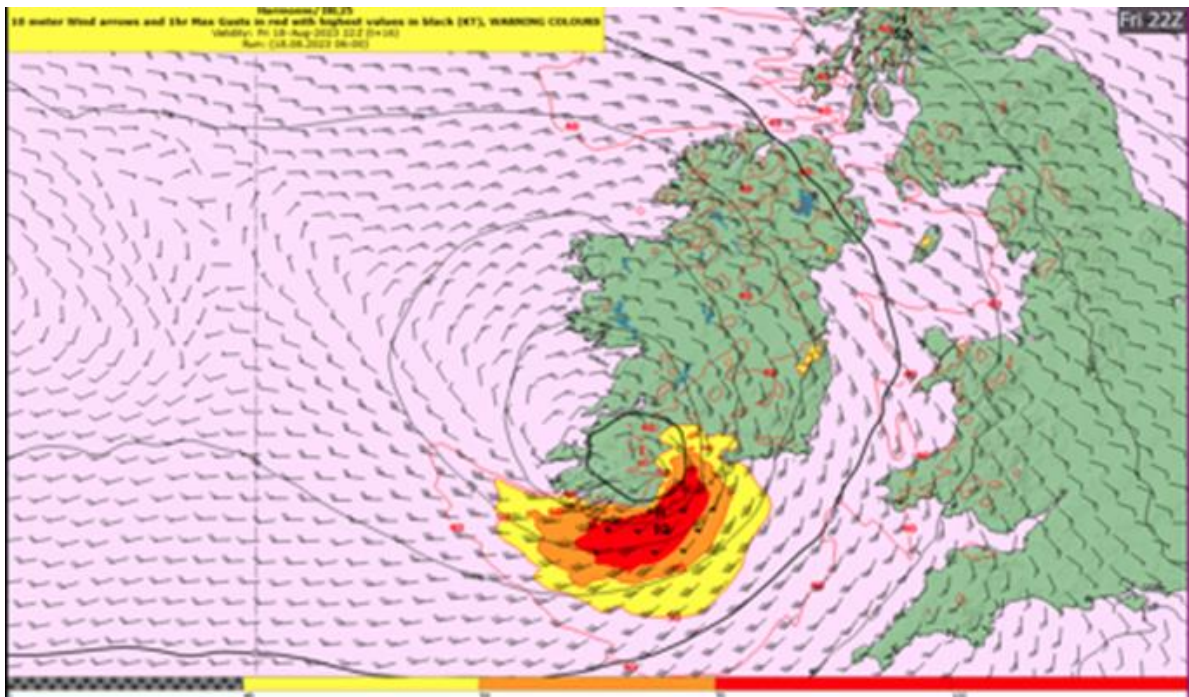
One of the key observations was a rapid decline in atmospheric air pressure (Figure 1) at one of the STREAM weather stations in Waterford. Atmospheric pressure is used as an indicator of weather. When a low-pressure system moves into an area, it usually leads to cloudiness, wind, and precipitation. While high-pressure systems usually lead to fair, calm weather.

Figure 1. STREAM measurement of atmospheric air pressure in Waterford.



A dramatic drop in air pressure can lead to strong winds and Betty’s strong winds caused widespread disruption, with fallen trees and power outages reported in many areas. Storm Betty brought gusts of up to 130kmh and saw Met Éireann announce their second named storm of 2023 and they issued orange warnings for both wind and rain (Figure 2).

Figure 2. Met Éireann forecast of wind strength during storm Betty.



The STREAM project is part funded through the ERDF Ireland Wales Programme



In Waterford the STREAM anemometer showed a maximum gust of approximately 70 Km/ Hour with winds of over 50 km for over a three hour period as storm Betty passed (Figure 3).

Figure 3 wind speed Km/Hour recorded by a STREAM weather station in Waterford.

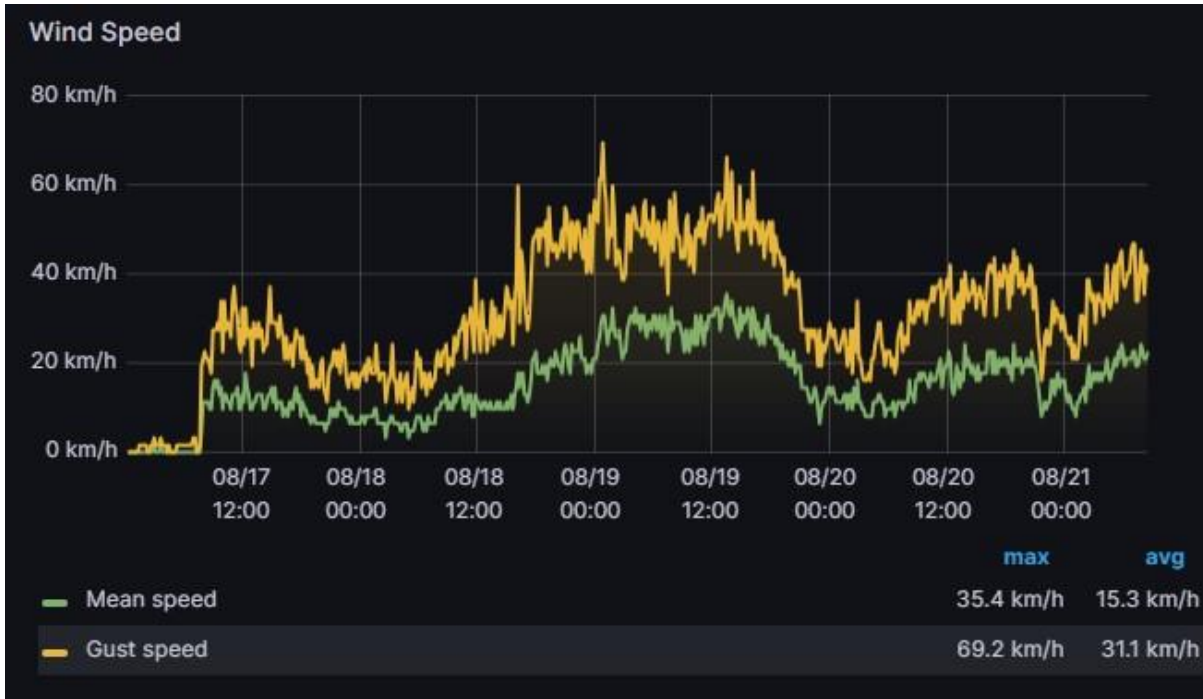
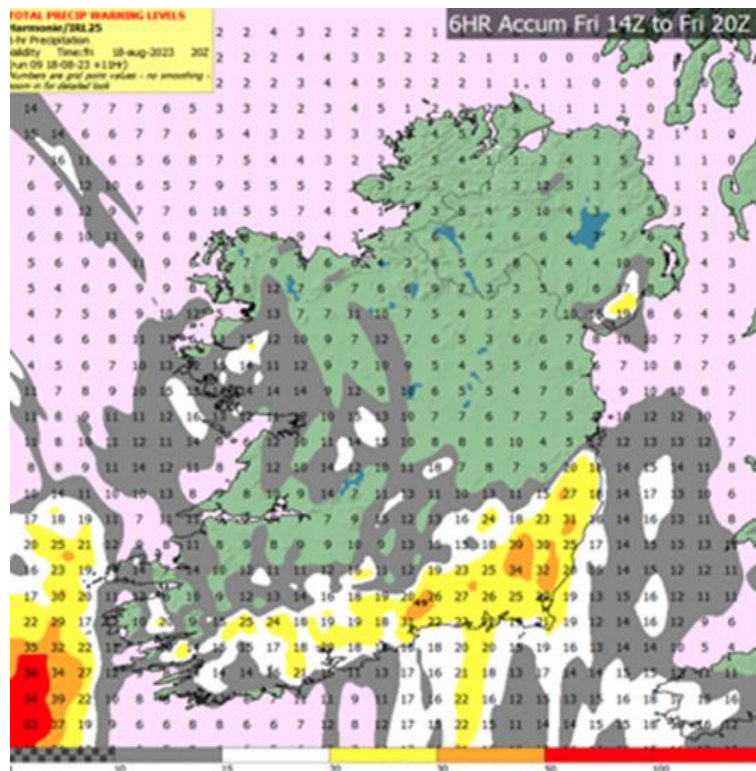


Figure 4 Met Éireann rainfall 6 hour accumulation Friday 18th August 2023.

Valentia Observatory, located in Co. Kerry, documented an unprecedented hourly rainfall record during Storm Betty last week. Reported by Eoghan Moloney on Tuesday, August 22, 2023, in the Irish Independent, this remarkable event occurred as the eye of the storm neared Ireland on Friday night (figure 4). During a single hour, County Kerry encountered 36.2mm of rainfall – exceeding an inch of rain – within just 60 minutes. This intense downpour led to significant issues, including the some roads becoming impassable, along with reports of basement flooding and inundation in low-lying areas.





STREAM

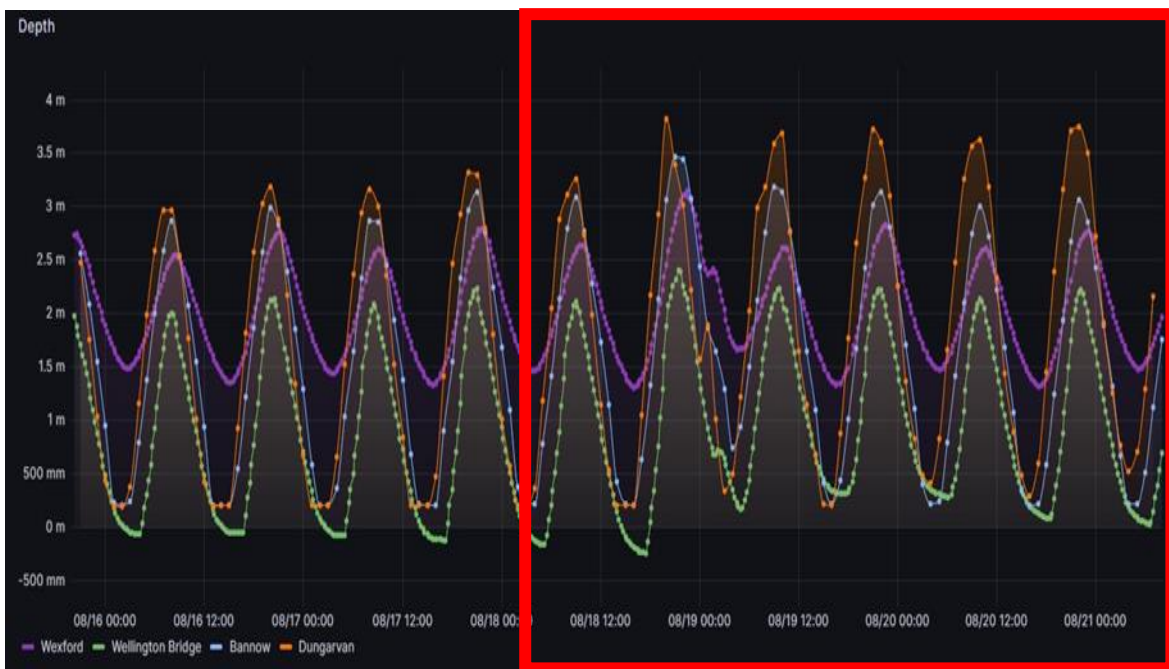
The STREAM rain gauge in Waterford recorded a peak deluge of nearly 55 mm of rain using a Gill single spoon tipping bucket technology with an accuracy of: +/- 2 % (Figure 5) .

Figure 5 STREAM rainfall gauge showing the measurements between Friday 18th to Saturday 19th August 2023.



The water quality sensors in Wexford, Wellington Bridge, Bannow and Dungarvan showed some disruption in their tidal cycle pattern on the 19th of August probably on account of the storm surge and heavy rain (Figure 6).

Figure 6. Showing tide height and a slight disruption in the tidal cycle.

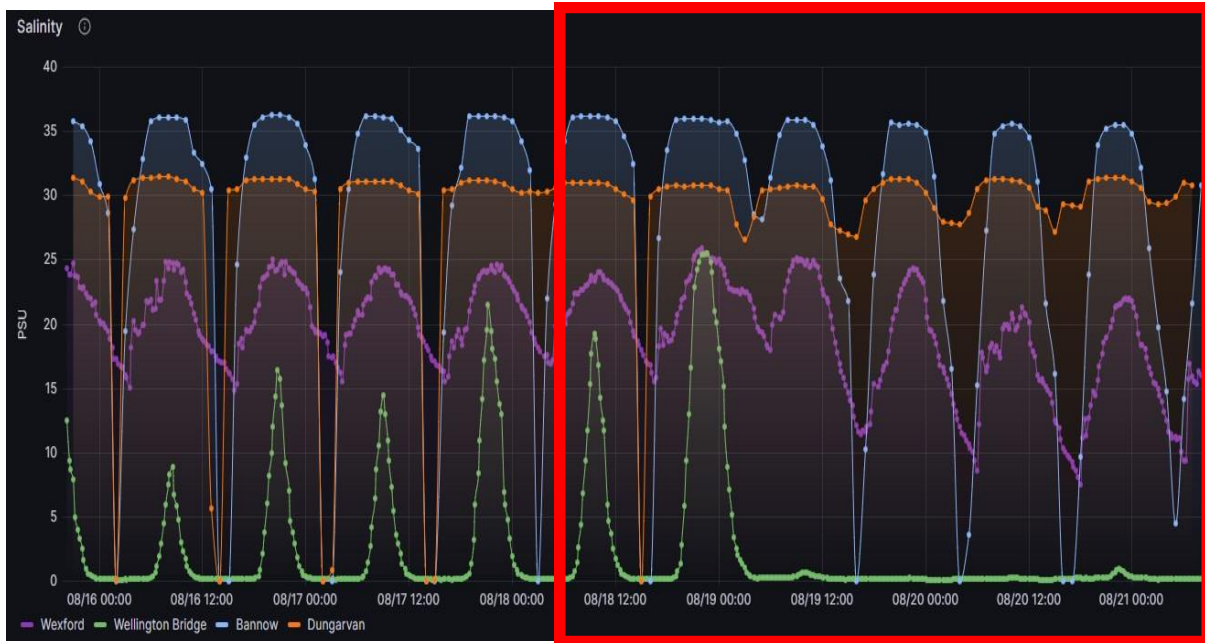


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Figure 7 illustrates the influence of the rainfall on the 18th on the STREAM recorded salinity levels recorded at Wellington Bridge and Wexford from 12 am on the 19th of August.

Figure 7 Salinity levels in Castletownbere, Wellington Bridge, Bannow and Dungarvan.



Due to the flooding there was a significant change (increase) in the fDOM recordings at Wellington Bridge and a more moderate change in Wexford (Figure 8). Fluorescent Dissolved Organic Matter (fDOM) denotes the portion of Coloured Dissolved Organic Matter (CDOM) that fluoresces. Both indicate organic matter in water which absorbs in the ultraviolet (UV) spectrum. As a surrogate for CDOM, fDOM detection provides a useful method for monitoring Dissolved Organic Matter (DOM) in natural water environments. The measurement of CDOM/fDOM is important because concentrations of CDOM can affect marine benthic plant and animal communities. The measurement of fDOM/CDOM is also suitable for monitoring a wastewater discharge, as the fluorescence of fluorescent dissolved organic matter (fDOM) indicates the total organic carbon (TOC) content. The concentration of fDOM in water can also provide insights into a water body's dispersion, transport, and mixing.

The measurement units for fDOM and CDOM are fluorescence units (RFU). fDOM_QSU: Fluorescent Dissolved Organic Matter that has been measured in Quinine Sulphate Units. CDOM mg/L (note Exo2 fDOM, is a proxy for RS-Hydro CDOM). Fluorescent Dissolved Organic Matter (fDOM) refers to the fraction of CDOM (Coloured Dissolved Organic Matter) that fluoresces.



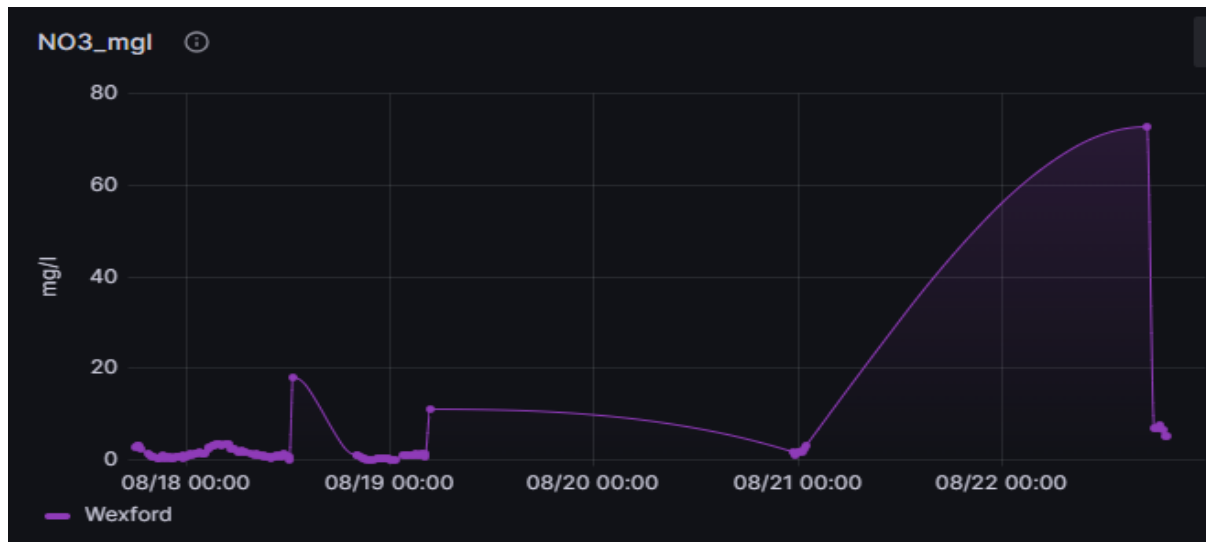


Figure 8 fDOM readings at Wexford and Wellington Bridge.



Nitrate after carbon is quantitatively the most important element for nutrition of microalgae, since it plays an important role on their lipid profile. A methodology named the Dual-wavelength correction scheme has been adopted by STREAM (Benyuan Yu 2022 pers. Comm.) and evaluated for the correction of absorbance organic matters might contribute. $\text{NO}_3\text{_mgl}$: measures the Nitrate in the water in milligrams per litre. There was a steady increase in nitrate levels recorded at Wexford (the only STREAM site at that time measuring NO_3). There was a significant increase in nitrate level after storm Betty passed as shown in Figure 9.

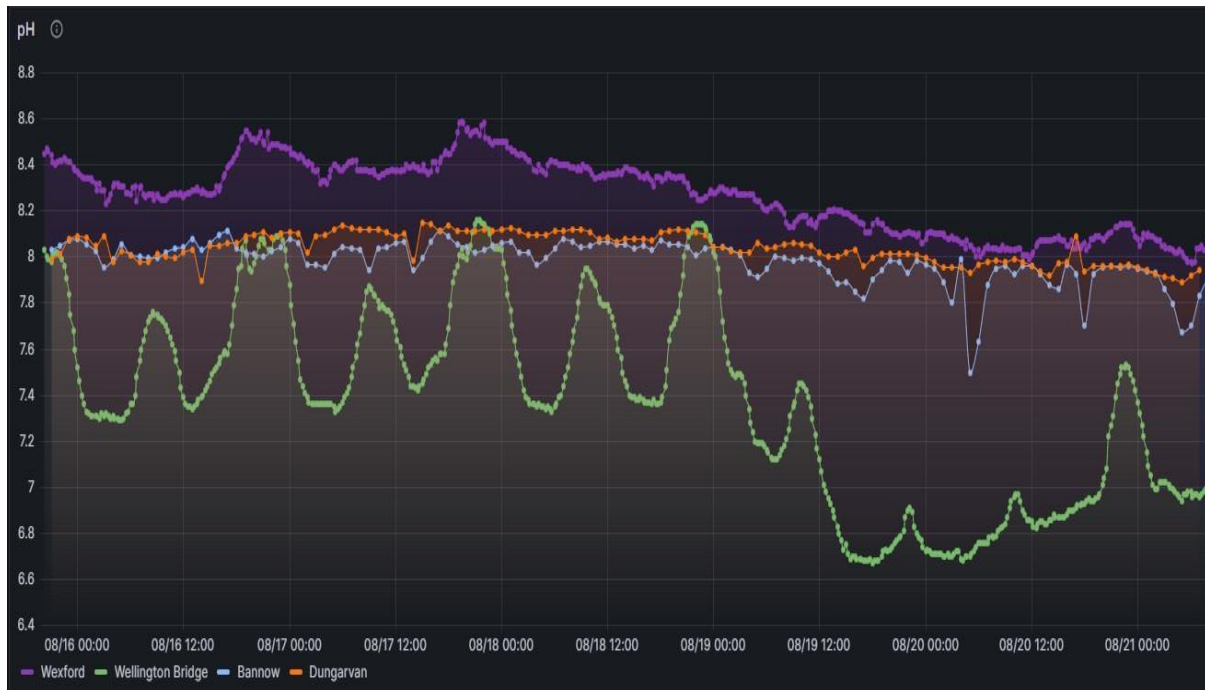
Figure 9 shows the nitrate level recorded at Wexford pier from the 18th to the 22nd August 2023.

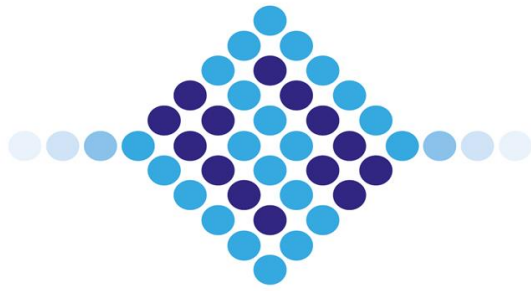




pH is a measure of the acidity or alkalinity of seawater on a scale of 0 to 14. A pH of 7 represents neutrality, values below 7 indicate acidity, and values above 7 indicate alkalinity. pH is an important indicator of water quality as it affects water treatment, chemical reactions, and the functioning of plants and animals. Changes in salinity (due to freshwater inputs) and nutrient runoff, can contribute to pH variations. As can be seen in Figure 10 there was a substantial change in pH recorded at Wellingtonbridge in the aftermath of Storm Betty.

Figure 10, pH recordings at Wexford, Wellingtonbridge, Bannow and Dungarvan.





STREAM

Sensor Technologies for Remote Environmental Aquatic Monitoring



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Waterford City River Rescue - Monitoring sites

Southern Regional Assembly - Breda Curran

Report

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