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MESTECH Marine & Environmental Sensing Technology Hub

Introduction

Cultural eutrophication is the process whereby a body of water becomes over-enriched with nutrients, in particular nitrogen (N) and phosphorus (P), resulting in algal blooms and subsequent death and decomposition which deplete oxygen levels in the water (i.e. hypoxia), leading to the loss of aquatic animals (e.g. fishes). This is caused by excess N and P. Agriculture is the major source to Irish rivers and estuaries, with 70% of P loads and 82% of N loads attributed to agricultural sources .

Hypoxia in the Gulf of Mexico has been linked to excessive N loading. Nuisance algal blooms in Lake Erie have been linked to agricultural P. Previous efforts have concentrated on measuring agricultural runoff directly using grab samples or spot measurements, but high frequency sampling will be essential to accurately characterize the extent and temporal resolution of agricultural impacts. Low-cost real-time nutrient sensors are critical for quantifying the influence of agriculture on freshwater, and more broadly, for effective water management throughout Irish, European, and American river basins.

Advantages & Disadvantages of Continuous Sensing

Advantages
- Low cost
- No sample handling artefacts
- Faster analysis time
- Spatial & temporal data
- Rapid detection of pollutants

Disadvantages
- Higher LOD
- Bio-fouling of optical sensors
- Manual collection of data
- Maintenance
- Power requirements
- Costly sensors

Ideal Sensor Characteristics

- Robustness
- Reproducibility
- High sensitivity
- Selectivity
- Limit of Quantitation
- Large linear range
- Remote sensing
- Multi compound analysis
- Minimal sample transformation
- Low fabrication cost
- Simple, compact apparatus
- Faster analysis time
- Low power requirements
- Low maintenance

Phosphate Sensor

Figure 1. Phosphate analyser prototype.

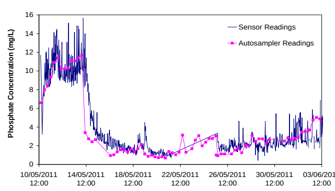
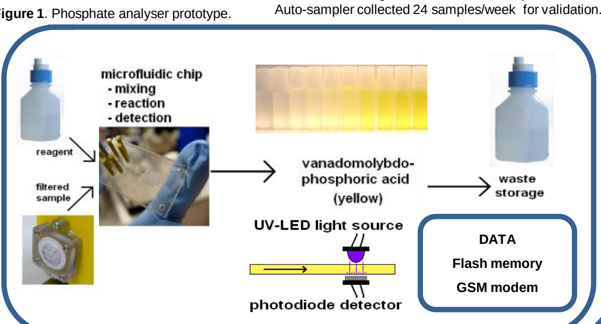


Figure 2. Kildare WWTP trial data. Sensor was installed in effluent discharge tank with 45 min sample interval. Auto-sampler collected 24 samples/week for validation.



Optical Colourimetric Sensor (OCS)

Figure 3. Multiple optical colourimetric sensors, used to monitor change in turbidity and chlorophyll.

Communications

Flotation

Optical head:
5 LEDs (Blue, Green, Amber, Red, IR) and 2 photodiodes at 90º and 180º to light path.

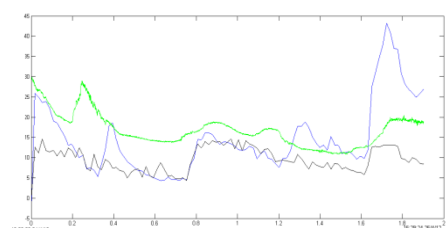


Figure 4 Data for a deployment of the OCS in Malahide, Dublin. Shows chlorophyll related turbidity events identified using the OCS.

Conclusion

Nutrient monitoring in real-time is a challenge due to sensor cost and reliability. This project will investigate the development of nutrient sensors for water quality monitoring. The phosphate sensor developed represents a viable, low cost, and reliable method for long-term monitoring of phosphate across a range of applications including wastewater and surface water monitoring. It can be expected to find significant applications in the monitoring of in-process and discharged effluent from municipal wastewater treatment plants, industry and other point sources of phosphate, as well as in the monitoring of surface waters known to be impacted by phosphate pollution. This project will examine methods for improving the detection limit of the sensor in order to broaden its application range. The OCS offers a low-cost solution for high density monitoring of water quality, with potential for algal bloom monitoring.

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NCSR National Centre for Sensor Research · Marine Institute Foras na Mara · Sea Change Casadh na Taoide · SSTI Strategy for Science, Technology and Innovation · NDP National Development Plan · DCU