



In-situ techniques for monitoring drinking water quality

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1

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Introduction

- Taste and odour (T&O) compounds **2-Methylisoborneol (2-MIB)** and **geosmin** are produced by cyanobacteria
- In drinking water earthy/musty T&O (detection level = 5-10 ng/L) affects customer's perception of water quality
- T&O removal requires costly treatment so early warning for T&O risk is crucial for water industries
- Manual sampling prevents real-time monitoring and a timely management response for T&O risk

Research aims

DNA work:

- Use geosmin synthase gene (geoA) prevalence in DNA of a water sample to predict geosmin concentrations
- Use community analysis to identify cyanobacteria species as geosmin producers

Sensor work:

- Investigate which in-situ water quality sensors could help predict T&O outbreaks

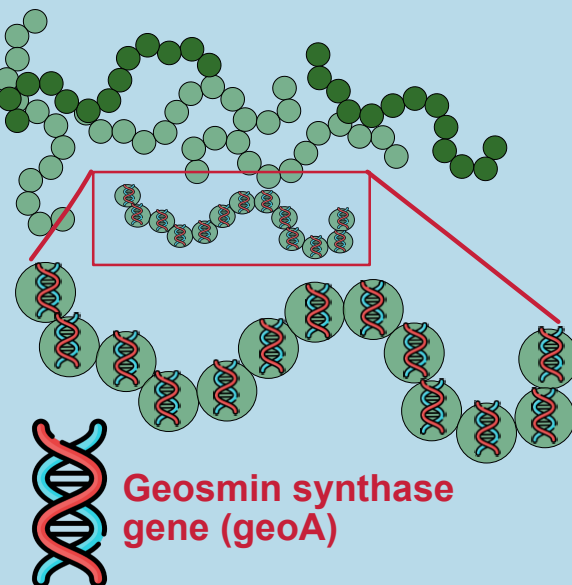
2-MIB



Geosmin



DNA work



Methods

- Geosmin and 2-MIB analysis at Welsh Water laboratory: SPE extraction and GC-MS analysis
- qPCR with geoA (geosmin synthase gene) and 16S rRNA
- Community analysis with Next Generation Sequencing (NGS): Algae (Rbscl) and Bacteria (16S rRNA)

Results

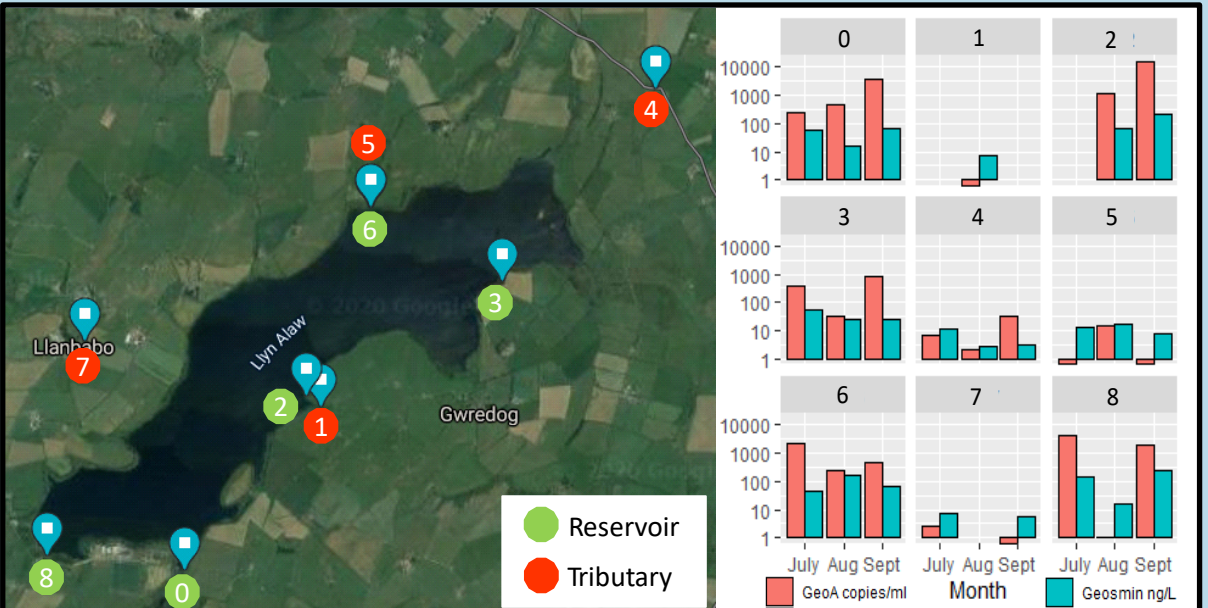


Figure 1: **Left:** Llyn Alaw reservoir indicating reservoir and tributary sample locations. **Right:** number of geoA gene copies and geosmin concentration set out for each location in July, August and September

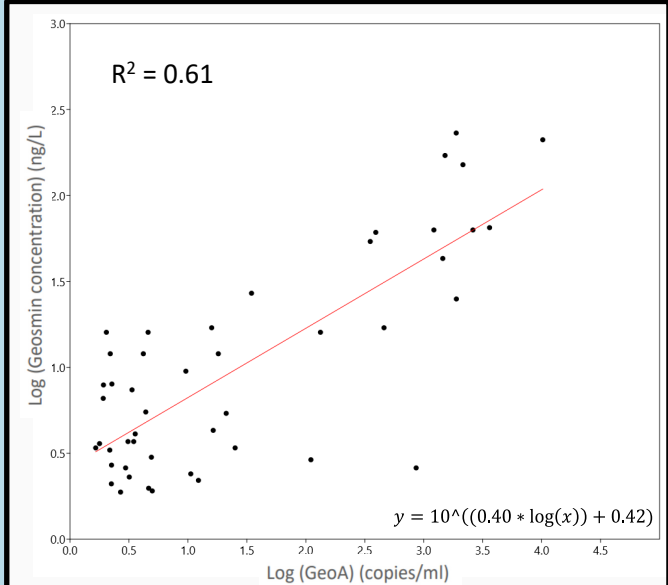


Figure 2: Correlation between Geosmin concentration and the copy number of the geoA gene

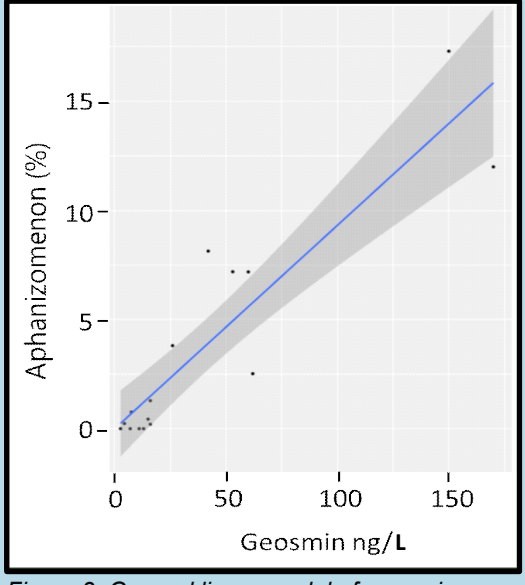


Figure 3: General linear model of geosmin concentration in Alaw against the percentage of Aphanizomenon sp. in the bacterial community

Sensor work

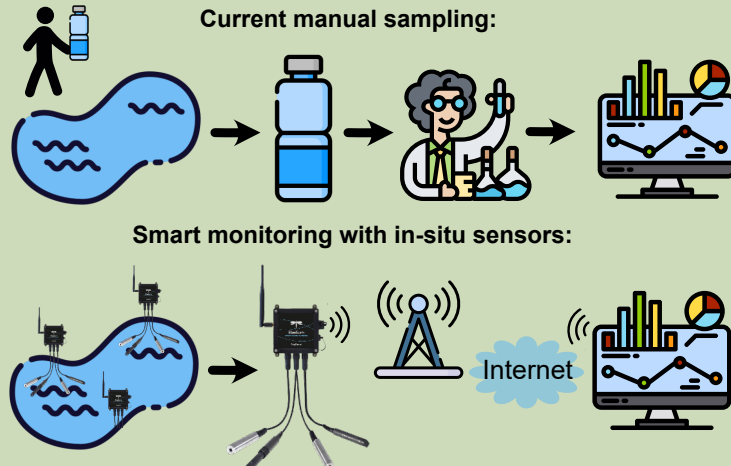
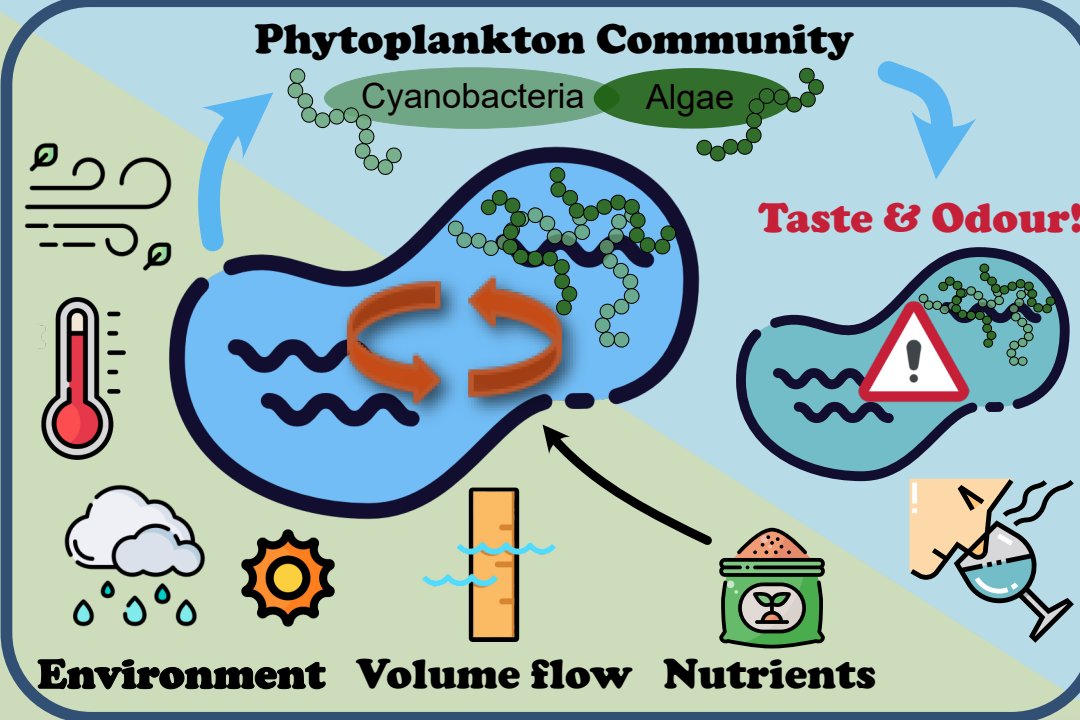
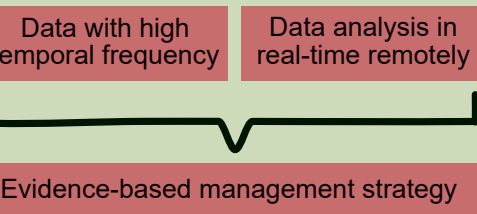


Table 1: Commercial sensors techniques for freshwater parameters

Sensor technique	Measurement method	Freshwater parameters
Optical	Absorbance (UV-Vis)	Nitrate/Nitrite
		CDOM
	Fluorescence	Turbidity
		fDOM
		Protein-like (Tryptophan) and Humic-like
		Photosynthetic pigments: Chlorophyll-a, Phycocyanin, Phycoerythrin
Electrochemical	Colorimetric (wet chemical)	Dissolved oxygen
		Nitrate/Nitrite
		Ammonium
	Irradiance	Phosphate
		Total Phosphorus
		Photosynthetically Active Radiation
Other	Ion Selective Electrode	pH
		Nitrate
	Polarographic/Galvanic	Ammonium
		Dissolved oxygen
	Inductive/Conductive	Electrical Conductivity
		Temperature
	Thermistor	Pressure

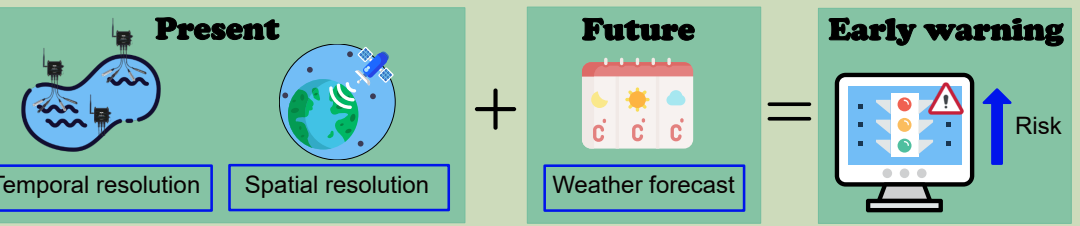


Smart monitoring



Future Sensor work

- Test in-situ nutrient sensors for Ammonium, Nitrate and Phosphate in laboratory and field
- Overview sensors + (dis)advantages
- Test nutrient trends in available datasets
- Mesocosm experiment
- Set up smart monitoring for T&O prediction



Key Messages DNA work

- GeoA gene copies/ml predict geosmin levels > 15 ng/L in Alaw reservoir (n=47)
- Dominant cyanobacteria species is not necessarily geosmin producer (Biomass ≠ geosmin concentration)
- Aphanizomenon sp. is probably geosmin producer in Alaw reservoir
- There is large spatial and temporal variation in phytoplankton community structure and geosmin production

Key Messages Sensor work

- No single water quality parameter predicts T&O outbreaks due to complex T&O triggers
- Smart monitoring system with multiple in-situ water quality sensors will help T&O prediction and early warning