About:

**Coupling Spatio-temporal Remote Sensing and automated *in-situ* IoTsensors to monitor and predict HABs and cyanotoxins.**

Case Study-Lake Victoria

Rationale

The comprehensive aim of this project is to come up with a mid-level geo-intelligent system for monitoring and short-term forecasting of cyanobacteria and algal blooms in the area of study. By employing automated Internet of Things (IoT) sensors and Earth Observation (EO) data, the Harmful Algal Blooms (HABs) monitoring and prediction can be achieved in near real-time.  
  
Algae, in limited concentration, are ecologically friendly however when an unanticipated bloom comes to pass, can have severe impacts on human health, aquatic ecosystems, form unsightly views and nuisance in points of impact and with cyanotoxins, initiated by the cyanobacteria being particularly problematic as they can be toxic and scum-forming, posing a risk to the ecosystem and to public health and as well detrimental to the economy.

The geoscientific preparedness to monitor and predict algal and cyanobacterial blooms of great material value to provide pre-warning to society and enable management processes to be activated in advance to limit the disastrous and catastrophic impact.

Previous work

Satellite data from the Sentinel 2 platform can be successfully used for estimating algal concentrations in lakes.

The advent and uptake of high resolution in-lake automated water quality sensing technology together with new satellite platforms now enables a step-change in data availability that could be used for monitoring and forecasting of cyanobacteria (and algal) blooms in lake Victoria.

Here I intend to utilize Earth Observation data, including from new satellite platforms, new in-situ sensor technology, available meteorological data, combined with machine learning techniques to provide a near real-time, intelligent capacity for assessing current state and providing short-term forecasts of likelihood of algal and cyanobacteria blooms in Lake Victoria.  
  
**Methodology**  
The project idea intends to aggregate Earth Observation Remote Sensing data from Google Earth Engine cloud platform to extract and analyse the presence of Chlorophyll-a pigment.

Parameters to be collected from dataset for Lake Victoria :

1. Ecological water quality parameters including:

* Chlorophyll-a surface concentration
* Suspended Particulate Matter (SPM)
* Lake Surface Temperature (LST)

2. Sustainability indexes (evolution of land cover - land use (1990 - 2020), evolution of pollution release into the lake due to demographic pressure

3. Time series (Long Short Term Memory) of meteorological observations.

Besides that, meteorological data (for the last few years together with water quality data supplied by the Lake Victoria Basin Health Monitoring. These data will be used to identify historic occurrences of algal and cyanobacterial blooms in that specified Lake.

Machine learning techniques will then be used with these data and with site characteristics to develop a probabilistic prediction of blooms. The algorithms will then be usable in real-time through the IoT utilising incoming EO and meteorological data, to provide a short-term forecast of the likelihood of a bloom, dependent on the weather conditions over the next few days. This approach will be complemented by analysing similarity in timing of blooms across nearby lakes, utilising the wealth of lakes for which EO data are available. Coupling the output of the coherence and forecasting studies will increase the number of lakes for which predictions can be made. The third part of the project will involve combining above-lake and within-lake automated sensors and manual sampling to collect water quality data from Airthrey Loch (on the University of Stirling campus). These data will be used to determine the efficacy of utilising data from the nanosatellite constellation, ‘Doves’, which provides data at different wavelengths and at higher spatial resolution than Sentinel 2, for monitoring and forecasting of cyanobacterial blooms, with the possibility of widening this approach using other water quality sensors deployed in the Forth catchment area.  
  
The student will be based at the University of Stirling. Training will be provided in key areas, such as remote sensing, machine learning, or limnology, as appropriate. This project would suit someone numeric and competent at coding, with an interest in the environment, and will include some field work.  
  
Applicants are strongly advised to make an informal enquiry about the PhD to the primary supervisor well before the final submission deadline. Applicants must send a completed application form (available here https://www.hydronationscholars.scot/apply), their Curriculum Vitae and a covering letter to the primary supervisor by the final submission deadline of 8th January.