NERC Knowledge Exchange Fellowship: Exploitation of satellite remote sensing for regulation and monitoring of inland water quality

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• Fellowship funded by NERC and supported by Satellite Applications Catapult with the aim of promoting and facilitating the use of **satellite remote sensing** for improved **regulatory monitoring** of inland and TRAC water quality.

• Building on and contributing to other research projects (GloboLakes, EOMORES etc.).

• UK’s first practical application of satellite data being used for statutory, operational monitoring.
1) Optical water type classification

- Remote sensing reflectance (Rrs) spectra assigned an OWT by calculating Mahalanobis distance.
- 13 distinct optical water types identified in global dataset.

2) Algorithm development and validation

- Assessed algorithms for calculating Chla, TSM and CDOM.
- Best performing algorithms per OWT combined in an ensemble switching algorithm for improved accuracy.
NERC 2-phase KEF

Feasibility study with SEPA to develop concept (February 2018 – January 2019)

1. Retune GloboLakes Chla algorithm
2. Produce maps of Chla concentration in Scottish lochs
3. Define a WFD satellite derived classification metric (e.g. adapted EQR boundaries).
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KEF to deliver change (January 2019 – December 2021)

1. Extend to a multi-parameter processing chain for Chla plus CDOM, turbidity and TSM (Google Earth Engine)
2. Increase geographical extent to cover UK and Ireland
3. Additional partners: SEPA plus EA, IEPA, NRW, Scottish Water, Anglian Water
4. Implement maps for operational use in water quality applications.

An operational algorithm for UK waters

GloboLakes chlorophyll-α (Chla) algorithm retuned for Scottish waters and Sentinel-2 sensor.

Preliminary results show Chla derived from satellite data compare well with ground-sample results.
Routine monitoring capability (1)

Number of cloud free days (Loch Leven example)

- Sentinel-2b producing data

95 cloud free images (at least 9 pixels) collected over Loch Leven in 1 year
Routine monitoring capability (2)

- Number of pixels per lake

Loch Lomond: 170155
Loch Awe: 96045
Loch Shin: 70554
Loch Ness: 134433
Loch Leven: 34692
Number of observable lakes

Many more lakes observable using Sentinel-2, particularly useful in areas inaccessible for ground-sampling.
Comparison with ground sampling methods

<table>
<thead>
<tr>
<th>Factor</th>
<th>SEPA ground sample</th>
<th>Sentinel-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of samples per year per lake</td>
<td>~12</td>
<td>~95</td>
</tr>
<tr>
<td>Number of lakes sampled per year</td>
<td>60</td>
<td>&gt;1000s</td>
</tr>
<tr>
<td>Spatial representation</td>
<td>1 sample location</td>
<td>&gt;10000s pixels</td>
</tr>
<tr>
<td>Number of equivalent samples</td>
<td>720</td>
<td>950 x 10^6</td>
</tr>
</tbody>
</table>

Sampling (+ WFD regulations etc.) are designed to seek the truth about water quality. Is this really what current monitoring methods are showing? Satellite remote sensing provides a more representative overview of the complete lake environment.
Uses of satellite remote sensing for monitoring and regulation

- As direct input into WFD classification
- To optimise reservoir management for efficient water treatment and early detection of quality issues
- As a sampling management tool to optimise ground-based measurements
- To identify regions of potential risk to water quality status

And many more...
Thank you
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