

British Geological Survey

Gateway to the Earth

The use of fluorescence to monitor groundwater microbiological quality

James Sorensen British Geological Survey





Unlocking the Potential of Groundwater for the Poor





The driver

 2 billion people consume drinking water contaminated with faeces (WHO, 2018)





- 500,000 deaths per year from diarrhoea alone
- Children under five



The driver – developed world

- USA, 750k 6 million cases waterborne illness per year from consuming groundwater (Maclear and Merkle, 2000)
- Private groundwater supply surprisingly common
- USA (12%), Ireland (17%)
- Effective treatment?



- 33% show evidence of faecal contamination in Ireland 1998-2008 (EPA)
- Monitoring?
- Contamination is episodic



The driver – developed world

Municipal supplies

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Lancashire boiled water 'safe' amid cryptosporidium alert - officials

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8 August 2015 | Lancashire

 Contamination is episodic, microbial monitoring is infrequent and off-site – online approach?







Tryptophan-like fluorescence (TLF)

- What is TLF?
- Tryptophan essential amino acid
- Quantified using field fluorimeters
- Simple, instant, reagentless, online



Instant results

- Why TLF?
- Linked to microbial activity in freshwater environments



Is TLF an indicator of thermolerant coliforms?

 Best predictor of thermotolerant coliform (TTC) presence/absence and enumeration in drinking water in Zambia (Sorensen *et al.* 2015)

Public supply



Private supply





Is TLF an indicator of thermolerant coliforms?







 Significant predictor of TTC presence/absence and enumeration in India; turbidity was not (Sorensen *et al.* 2016)



2018 - Defining TLF thresholds



Instant result

 Roaming survey of drinking water sources in Africa/India (n = 564)



Result within >18hr



Predicting presence/absence of TTCs



Sorensen et al. 2018a



Predicting number of TTCs

• Very strong correlation ($\rho = 0.80$, p-value < 0.001)





2018 - TLF online UK public water supplies

- Four public water supplies
- Fissured limestone
- Setup fluorimeters on raw water









TLF online UK public water supplies

- Online TLF (2 min) UK comparison with:
- online turbidity
- E. coli
- total bacterial cell counts by flow cytometry







Online indicators and *E. coli*





Online indicators and total bacteria



Total bacterial cell counts (1000 cells/mL)







Adding turbidity data

- Turbidity





Causation?



- Laboratory TLF E. coli correlation $R^2 = 0.98$
- Majority intracellular

- *E. coli* fluoresce at TLF wavelengths
- *E. coli* used for the industrial production of tryptophan



Overcoming limitations

- Environmental
- temperature, turbidity, inner-filtering effect
- Uniqueness of TLF to *E. coli*
- Fluorescence interference

Instant advice to consumers





Current work

Innovate UK





 Improving sensor technology



 Expanding beyond raw water



 Understanding falsepositives



Conclusions

- Tryptophan-like fluorescence (TLF) is:
- Indicative of the presence/absence and number of TTCs/*E. coli* in drinking water
- Superior to turbidity as an online indicator of microbial water quality
- Quantified using in-situ/portable existing, commercially available sensors



Instant result



Referenced papers

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Any questions?

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