British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Tryptophan-like fluorescence (TLF): A real-time indicator of faecally contaminated drinking water

Background

Drinking water contaminated with faeces is still consumed by 1.8 billion people globally and there is a need for easy-to-use, rapid techniques to screen drinking water. A possible solution is tryptophan-like fluorescence (TLF). Multiple studies have now shown that faecally contaminated drinking water sources have higher levels of TLF and that TLF is correlated with concentrations of thermotolerant coliforms, including *E. coli* (Baker *et al*., 2015; Sorensen *et al.*, 2015; Sorensen *et al*. 2016).

What is tryptophan-like fluorescence?

Tryptophan is an essential amino acid that fluoresces at an excitation wavelength of 280 nm and an emission wavelength of 350 nm. The term tryptophan-like fluorescence (TLF) is used because there are multiple compounds that can fluoresce at similar wavelengths. TLF occurs in high concentrations in human and animal waste and is a well-known indicator of wastewater in the environment. It is also known that *E. coli* cells directly emit TLF and also produce compounds, including tryptophan, that fluoresce in the TLF spectrum

Figure 1. Testing a water sample instantly

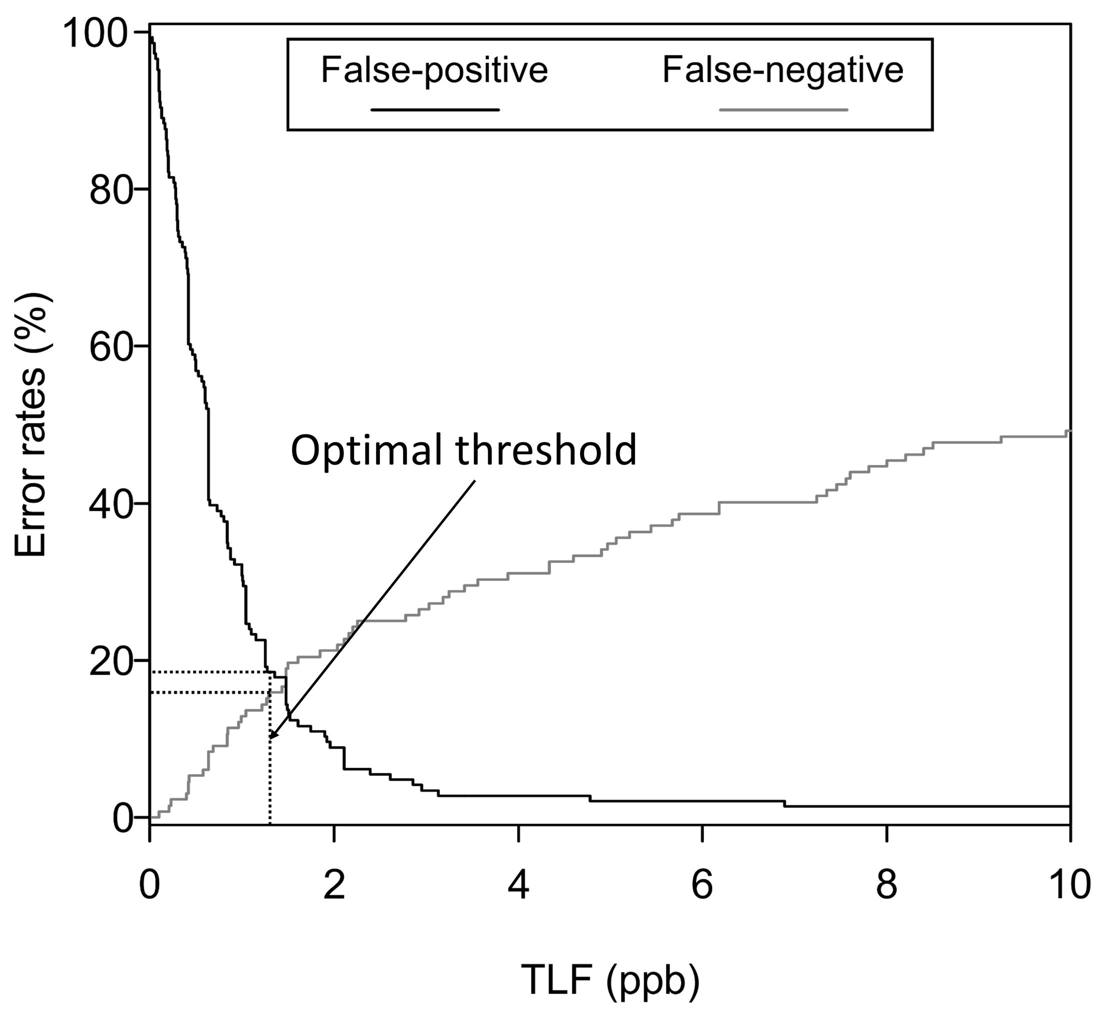


Figure 2. Receiver-operator curves for TLF as a predictor of thermotolerant coliform presence

Defining a tryptophan-like fluorescence threshold to indicate faecal contamination

Concurrent TLF and thermotolerant coliform datasets were collated from a mixture of groundwater- and surface water- derived drinking water sources in India, Malawi, South Africa and Zambia (*n* = 564). Receiver-operator curves were produced and an optimal TLF threshold of 1.3 ppb was defined to indicate contamination (Figure 2). At this threshold, the false-positive and false-negative error rates were 18% and 15%, respectively (Figure 2). Contaminated sites with <10 thermotolerant coliform cfu/100 mL could not be correctly identified (Figure 3), which we consider the current limit of detection. Above the proposed limit of detection the false-negative error rate was low at only 4%.

Advantages

Instantaneous result, no reagents, easy-to-use, low-powered using rechargeable or disposable batteries, deployable online, low false-negative error rate above 10 thermotolerant coliform cfu/100 mL .

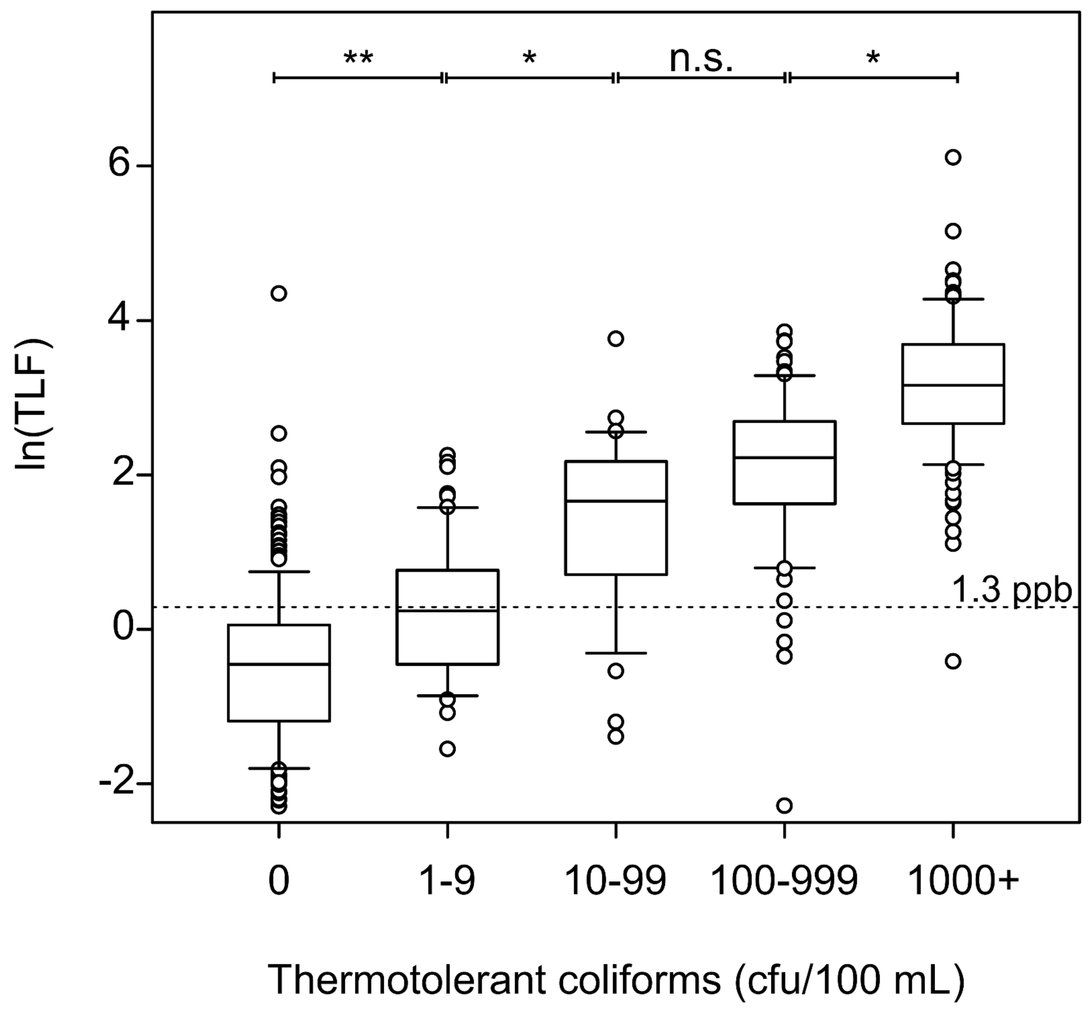


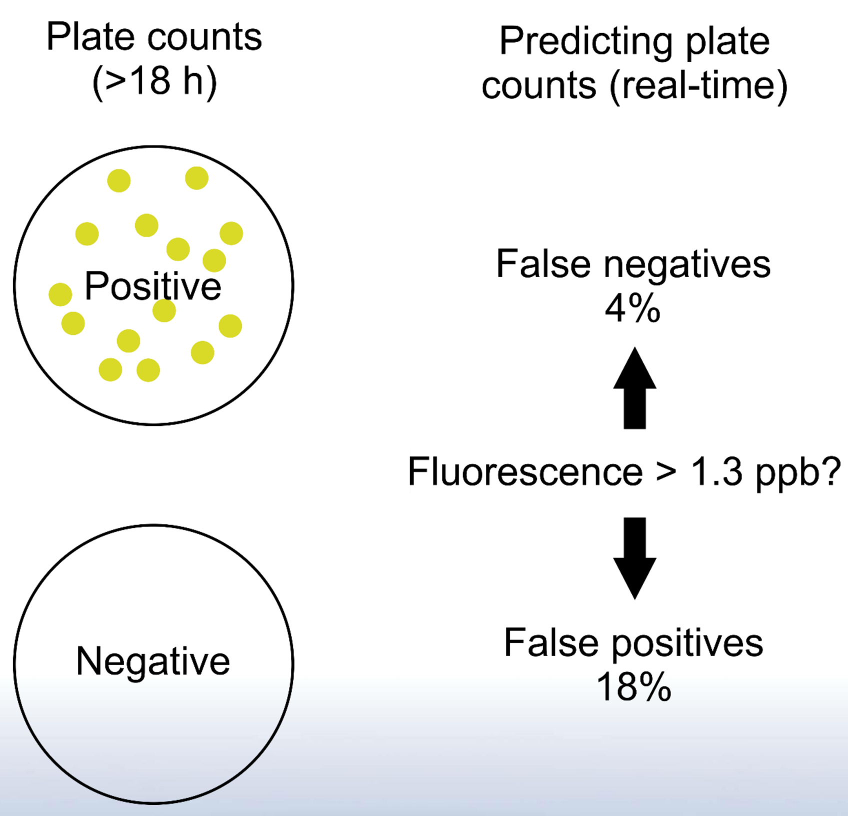
Figure 3. Boxplot of TLF for varying levels of microbial contamination.
Dunn's test denoted by: not significant = n.s., p = 0.05 (*), p = 0.01 (**) and TLF threshold of 1.3 ppb is shown

Limitations

Interference is possible, including from: turbidity, temperature, and other fluorescent compounds. Some automated correction for interferents may be possible, e.g. temperature because the response is linear (Khamis *et al*., 2015). False-positive error rates are too high (18%). TLF is likely to be more resilient in the environment than thermotolerant coliforms (Sorensen *et al*., 2015) and it could be that faecal indicator bacteria transit to a nonculturable state rapidly whilst the TLF signal remains and still correctly indicates a source is at-risk.

Conclusion

TLF is a viable solution for the rapid detection of faecally contaminated drinking water, which 1.8 billion people still consume globally. An easy-to-use, rapid method would facilitate increased drinking water testing and encourage behavioural change in communities in the strive towards meeting the UN Sustainable Development Goals



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