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Using a novel *in situ* fluorescence sensor to monitor biological contamination in the Hooghly River, Kolkata, India.

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Background

- Large rivers, such as the River Ganges, provide crucial water resources
  - Ganges River basin is home to 40% of the Indian population (approx. 540 million people) [1]
- Such systems face significant challenges from a range of anthropogenic and environmental influences
  - E.g. 3 billion litres of urban wastewater enters the Ganges daily, only 25% of which is treated by sewage treatment works [2]
- Monitoring such large scale systems is time consuming and expensive
  - 14 Central Pollution Control Board monitoring points on the Ganges, sampled <monthly [3]
  - 4 core parameters measured (pH, DO, BOD & faecal coliforms), other parameters are reported in academic papers but not officially monitored or regulated [3]

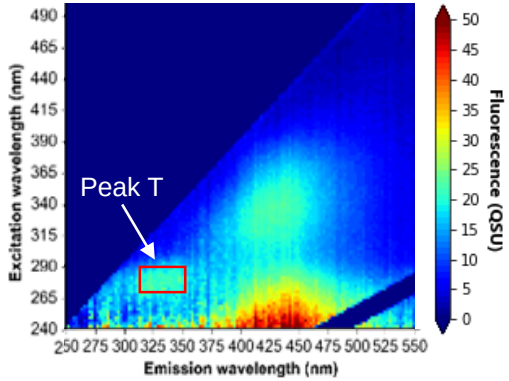
[1] Bowes et al. (2020) *Environmental Monitoring and Assessment,* 10.1007/s10661-020-08456-2
[2] Jin et al. (2015) *Sensors*, 10.3390/s100402460
[3] Mariya et al. (2019) *Environmental Monitoring and Assessment*, 10.1007/s10661-019-7625-7

Peak T fluorescence

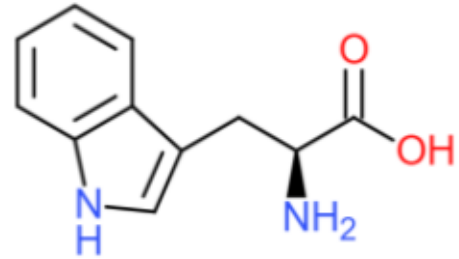
- Fluorescence spectroscopy has been used to characterise fluorescent organic matter (FOM) in waters around the globe over the past 20-30 years.
  - Much of this research has focussed on marine systems
  - More recently freshwaters have been explored in more detail, using fluorescence to understand water quality and composition

- Peak T fluorescence is associated with biological activity, closely resembling the fluorescence signature of the amino acid tryptophan.

- Technological developments mean this fluorescent organic matter can now be monitored using *in situ* optical sensors.



EEM of Hooghly River (Kolkata, India); Peak T region labelled.



Chemical structure of L-Tryptophan

Field locations

- The Hooghly River is a distributary of the Ganges
  - Hooghly River begins at Farakka and flows through the state of West Bengal and into the Bay of Bengal

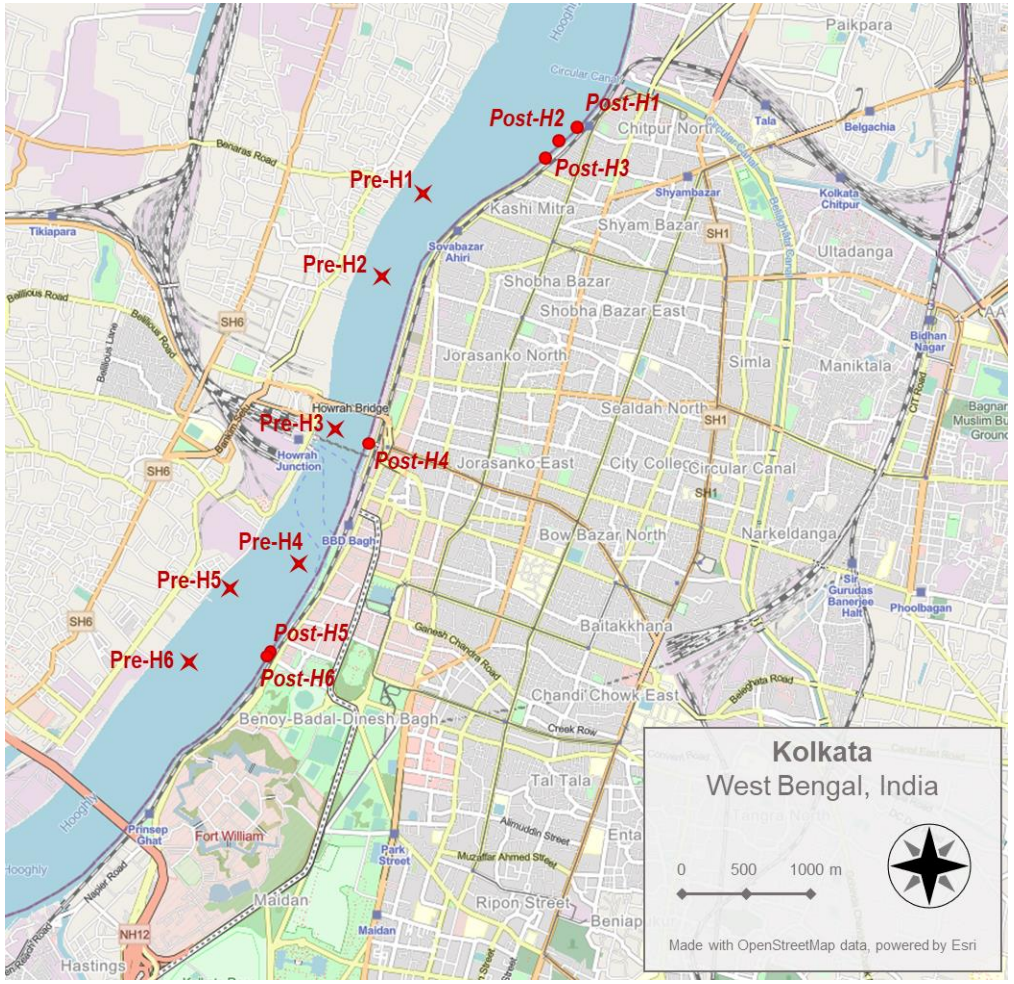
Map of India with the West Bengal region located.
Map obtained from Google Earth Pro (7.3.4.8248).

Field locations

- The Hooghly River is a distributary of the Ganges
  - Hooghly River begins at Farakka and flows through the state of West Bengal and into the Bay of Bengal

- Samples were collected within urban Kolkata
  - Population of ~5 million within the city limits; ~14.8 million in the metropolitan area
  - From Baghbazar to Eden Gardens

- Hooghly River samples were collected as part of two sampling regimes
  - Pre-monsoon (March 2019): 6 samples collected as part of a boat survey
  - Post-monsoon (December 2019): 6 samples collected from accessible locations along the river bank (Kolkata-side) during across two days



Map of sampling locations on the Hooghly River for pre-monsoon (Mar '19) and post-monsoon (Dec '19) sample collection and VLux TPro deployment. ✕ pre-monsoon ● post-monsoon

Methods

- VLux TPro sensor (Chelsea Technologies Ltd., UK) deployed *in situ*, providing real-time fluorescence data.
  - Data internally corrected for turbidity and absorbance
  - Sensor also providing information regarding CDOM and chlorophyll-α fluorescence
  - Fluorescence data provided in quantitative units (quinine sulphate units, QSU)

- Alongside the deployment of the VLux TPro, physicochemical parameters were measured in the field using handheld meters.

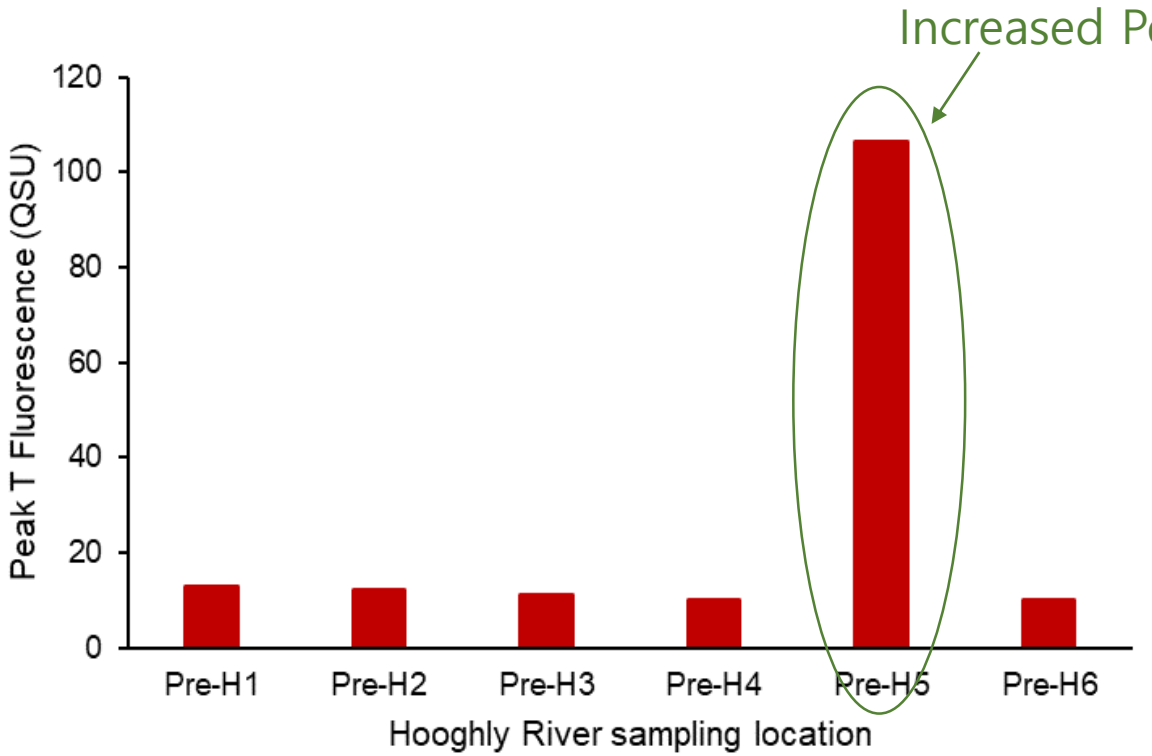
- Water samples were collected and processed to obtain nutrient concentrations and *E. coli* & total coliform (TC) counts.


VLux TPro sensor

Aim: To deploy a novel fluorimeter *in situ*, for the real-time detection of biological contamination and elevated microbial activity in a complex surface freshwater system.

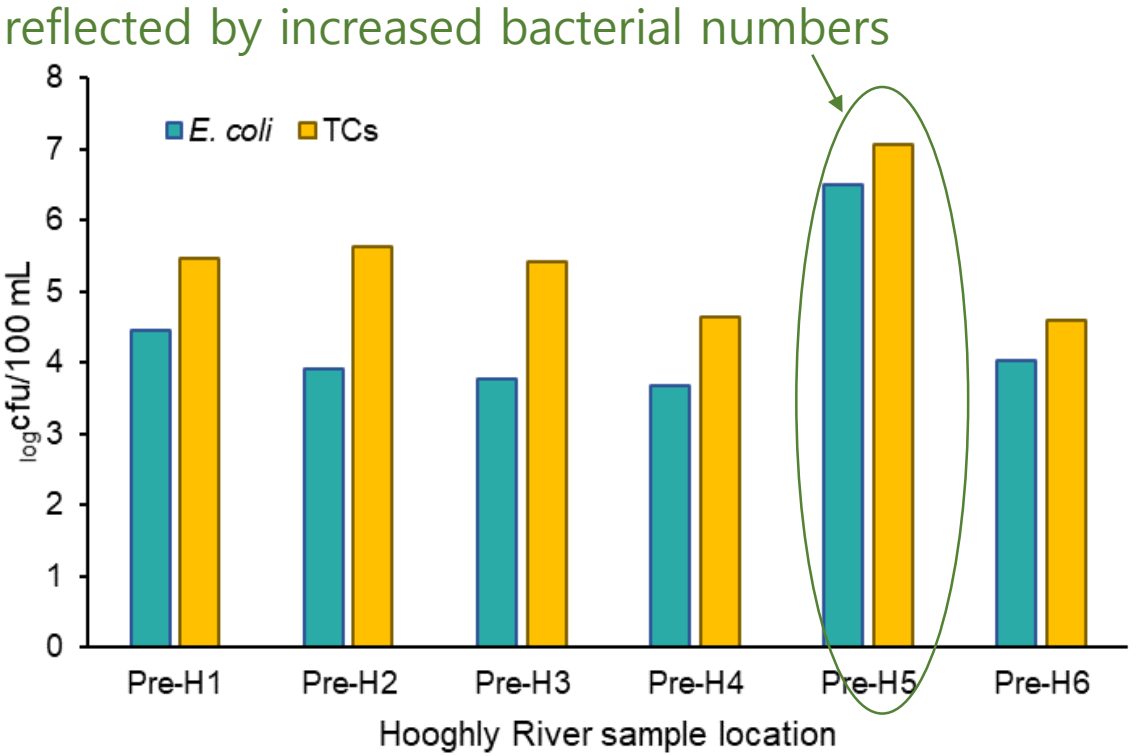
Pre-monsoon sampling (Mar’ 2019)

Peak T fluorescence



Hooghly River Peak T fluorescence intensity (QSU) data obtained from the *in situ* deployment of the VLux TPro. Data for the pre-monsoon samples, collected March 2019.

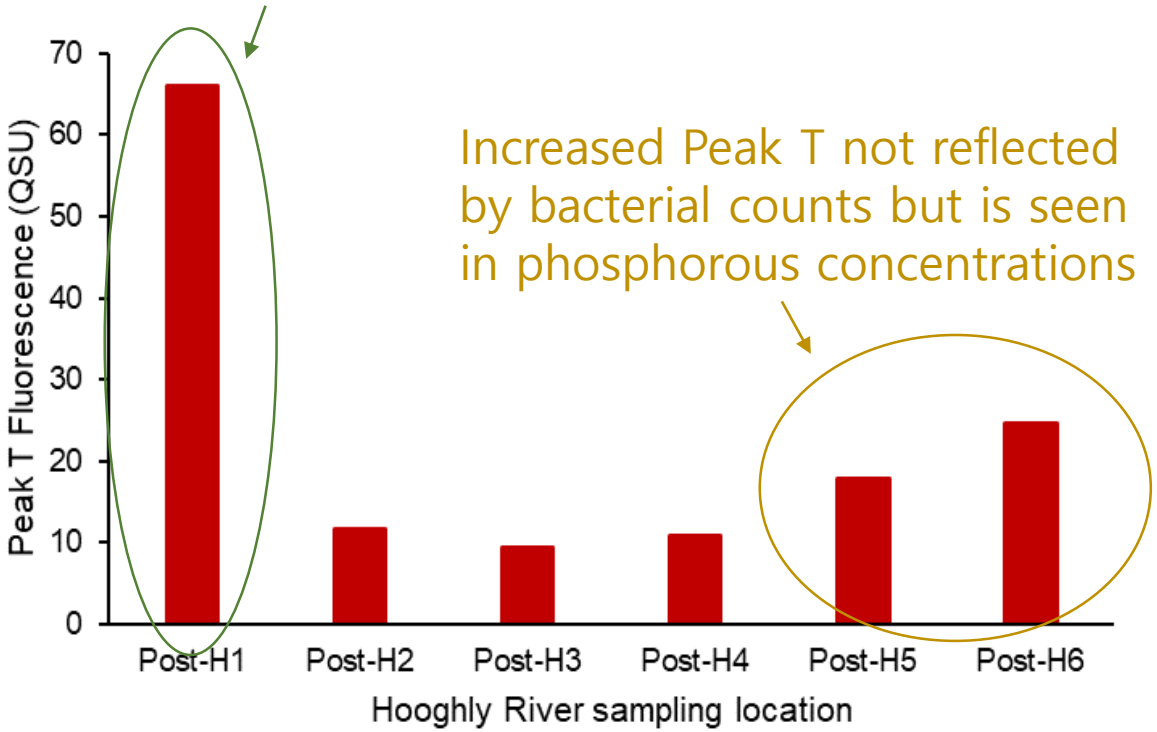
Bacterial enumeration



Bacterial enumeration data for E. coli and total coliforms (TCs) for the River Hooghly samples. Data for the pre-monsoon samples, collected March 2019.

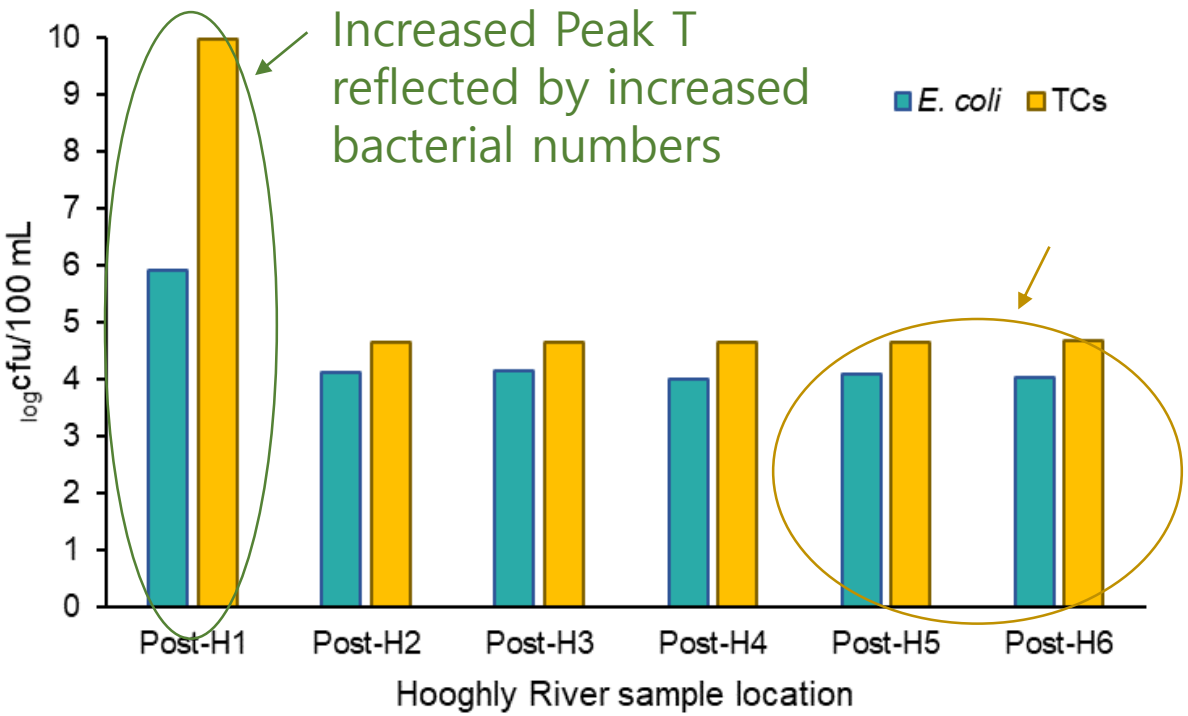
Post-monsoon sampling (Dec' 2019)

Peak T fluorescence



Hooghly River Peak T fluorescence intensity (QSU) data obtained from the *in situ* deployment of the VLux TPro. Data for the post-monsoon samples, collected December 2019.

Bacterial enumeration



Bacterial enumeration data for E. coli and total coliforms (TCs) for the River Hooghly samples. Data for the post-monsoon samples, collected December 2019.

Conclusions

- *In situ* deployment of the VLux TPro provides reliable quantitative fluorescence intensity data in real-time.
- The VLux TPro successfully identified biological contamination events.
- The VLux TPro potentially identified elevated microbial activity, related to nutrient loading (e.g. increased phosphorous) rather than black-water pollution.
- With the supporting evidence from field and laboratory data, we propose the application of Peak T fluorescence as a biological water quality parameter.
- Further work is needed to determine the feasibility of long-term catchment-wide deployment of the VLux TPro for monitoring microbial activity and pollution events in freshwater at high spatio-temporal resolutions.

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