

Early warning detection of water contamination in the Kinneret watershed's streams using advanced spectral devices

Eyal Bitkover¹, Tehila Asheri-Arnon², Meir Rom² and Giora Rytwo^{1,3}

1. M.Sc in water sciences program, Tel-Hai academic college, Kiryat Shmona, Israel.
2. Central lab and Kinneret watershed unit, Jordan district, MEKOROT water company, Israel.
3. Environmental Physical Chemistry Laboratory, MIGAL, Galilee Research Institute, Kiryat Shmona, Israel.

INTRODUCTION

Background

Streams and rivers are susceptible to various contaminations intrusions, such as:

- Agricultural lands leachates (fertilizers and pesticides)
- Cowsheds, chicken coops, fish ponds and partially treated wastewater
- Tourism
- Industry



Figure 1: Dead fish in the Yarkon river after a sewage spill (Haaretz, 2017).

Hence, rapid detection of pollution events in watersheds, may reduce, or even prevent health risks to water consumers and bathers, damage to ecosystems, and financial costs of treating the contaminated water.

UV/Vis spectroscopy

UV / UV-Vis spectroscopy is an important tool in analytical chemistry for the following reasons:

- High sensitivity
- Simple and relatively inexpensive equipment
- A wide range of molecules that absorbed in these ranges (mainly in the UV range)
- Variety of instruments
- Mobility



Figure 2: Online in-situ UV/Vis spectrophotometer equipped with automatic cleaning brush.

“The addition of a continuous online UV/Vis spectrometer probes to the monitoring array of Kinneret watershed's streams and rivers, while finding a suitable and reliable calibration model for each of the measured parameters, may improve any water monitoring systems, reduce the number of false alarms and provide real warnings / alarms within a short period of time.”

OBJECTIVES

- Examination of the suitability of two innovative commercial UV/Vis spectrophotometers for online detection and warning of stream contamination in selected monitoring stations in Lake Kinneret watershed.
- Adding a new layer of online in-situ UV/Vis spectrophotometer measurements to the calculation of the water quality index.

METHODS

- Installation of the devices at the new monitoring stations

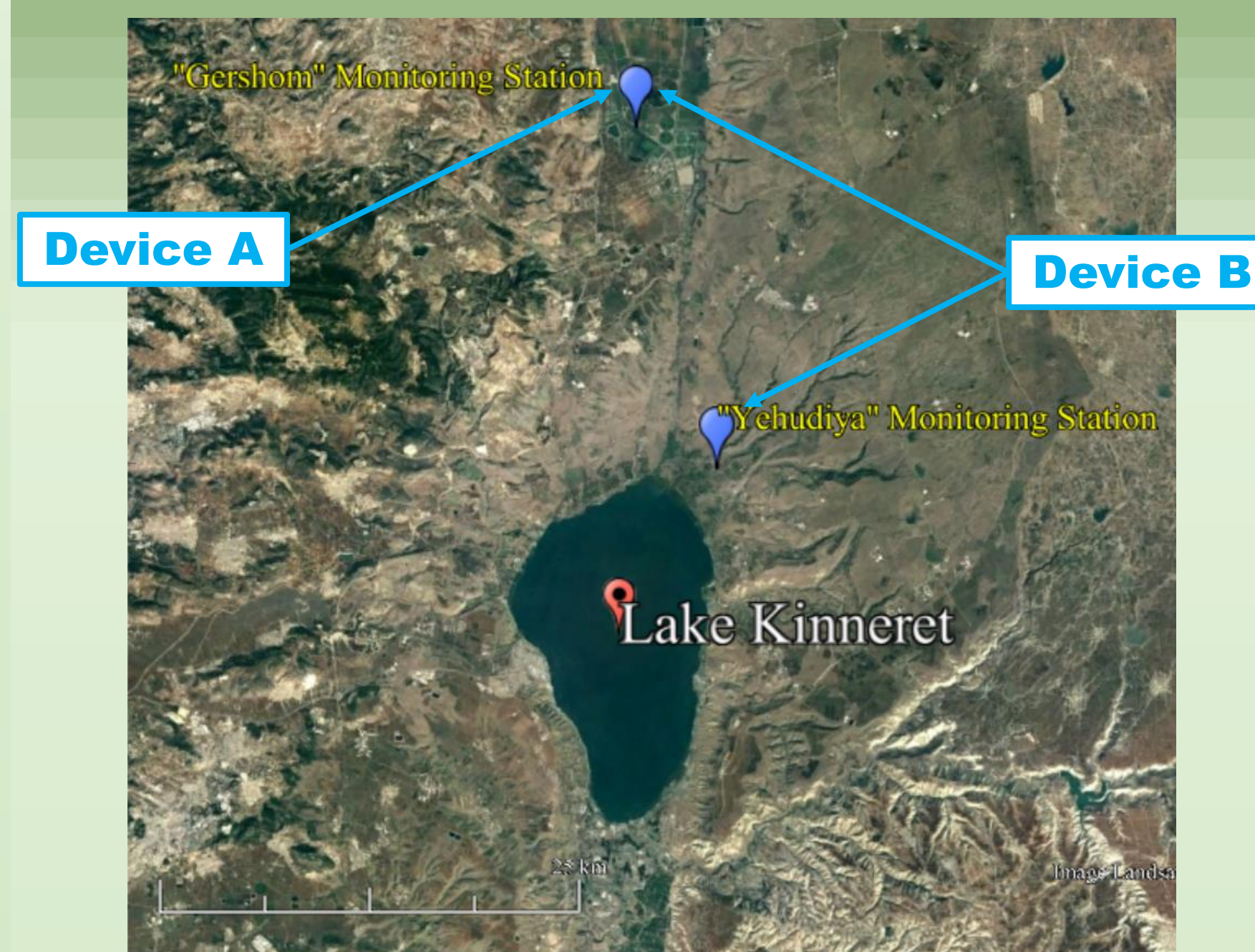


Figure 3: Generalized locations of Mekorot's new monitoring stations: "Gershom" and "Yehudiya river".

- Adjustment of the measuring path lengths and light intensity.
- Application specific calibration: Calibration of the devices for specific water quality parameters (TOC, DOC, COD, NO₂-N, NO₃-N, NH₄-N and turbidity) by:
 - multiple sampling of measured river (surface) water
 - Lab analysis of the samples for each of the water quality parameters
 - Creation of statistical calibration models for each of the water quality parameters using Multi Linear Regression method (including performing residual analysis via standard methods of regression diagnostics)
- Comparison of the spectral devices measurements to the physicochemical instruments readings
- field experiments for examination of the alarm parameters sensitivity and response time of each of the two devices for varying concentrations of organic simulants (such as potassium hydrogen phthalate and ascorbic acid) and representative herbicides.

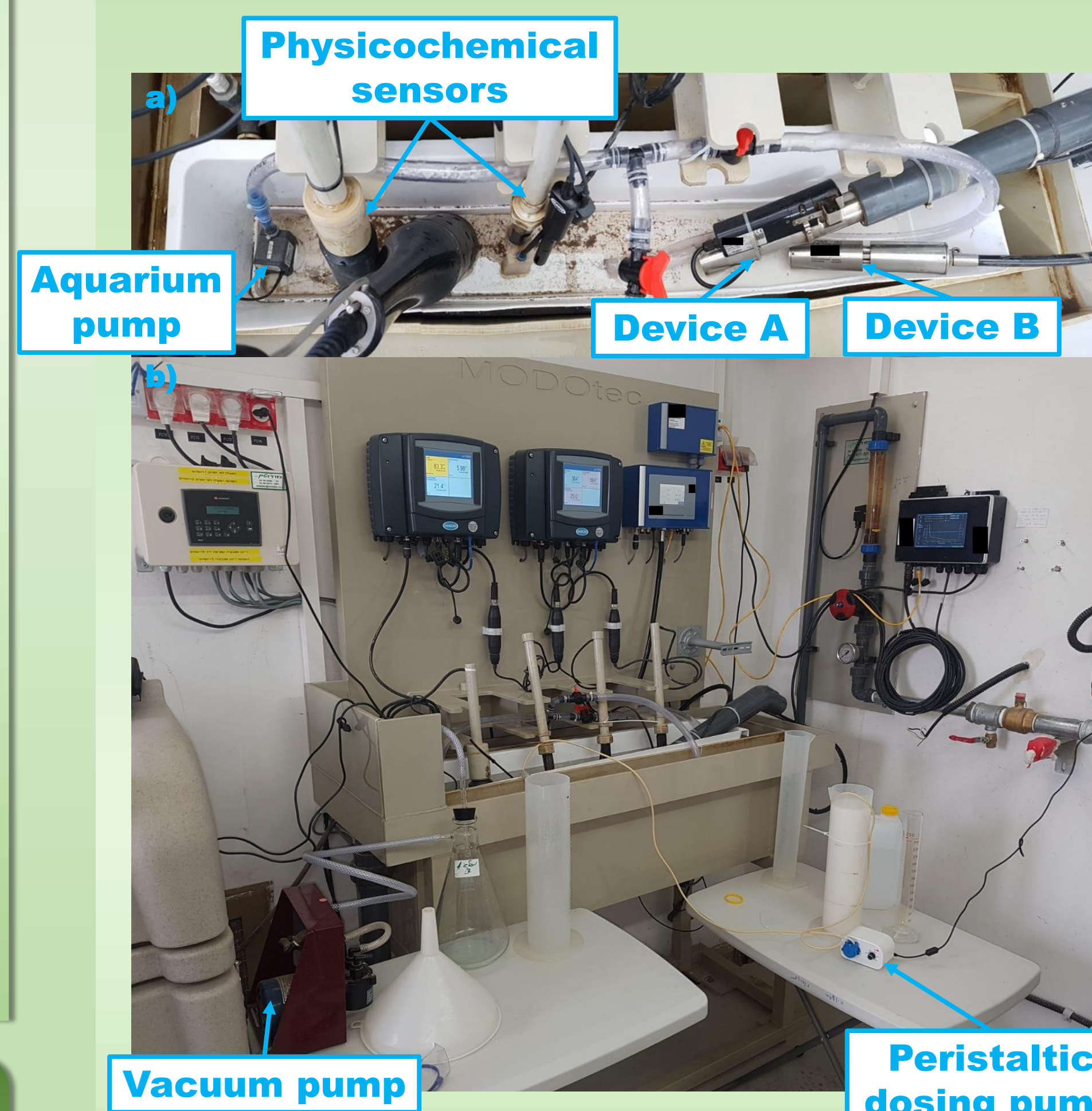


Figure 4: (a) The experimental system: The experimental system consists of a polyethylene planter filled with river water which are circulated by a 2000 L/h aquarium pump. The spectral devices (device A and device B) and the physicochemical instruments (pH, turbidity, redox and EC electrodes) are submersed in the river water. (b) Dosing system and purging system: During the field experiments, measured volumes of a pollutant/simulant solution are added to the river water in the planter and readings are recorded on all devices. The pollutant/simulant are fed in a continuous manner using a peristaltic pump or manually. In order to avoid any contamination of the basin, the polluted river water are drained using a receiver bottle connected to the planter drainage and a vacuum pump.

PRELIMINARY RESULTS

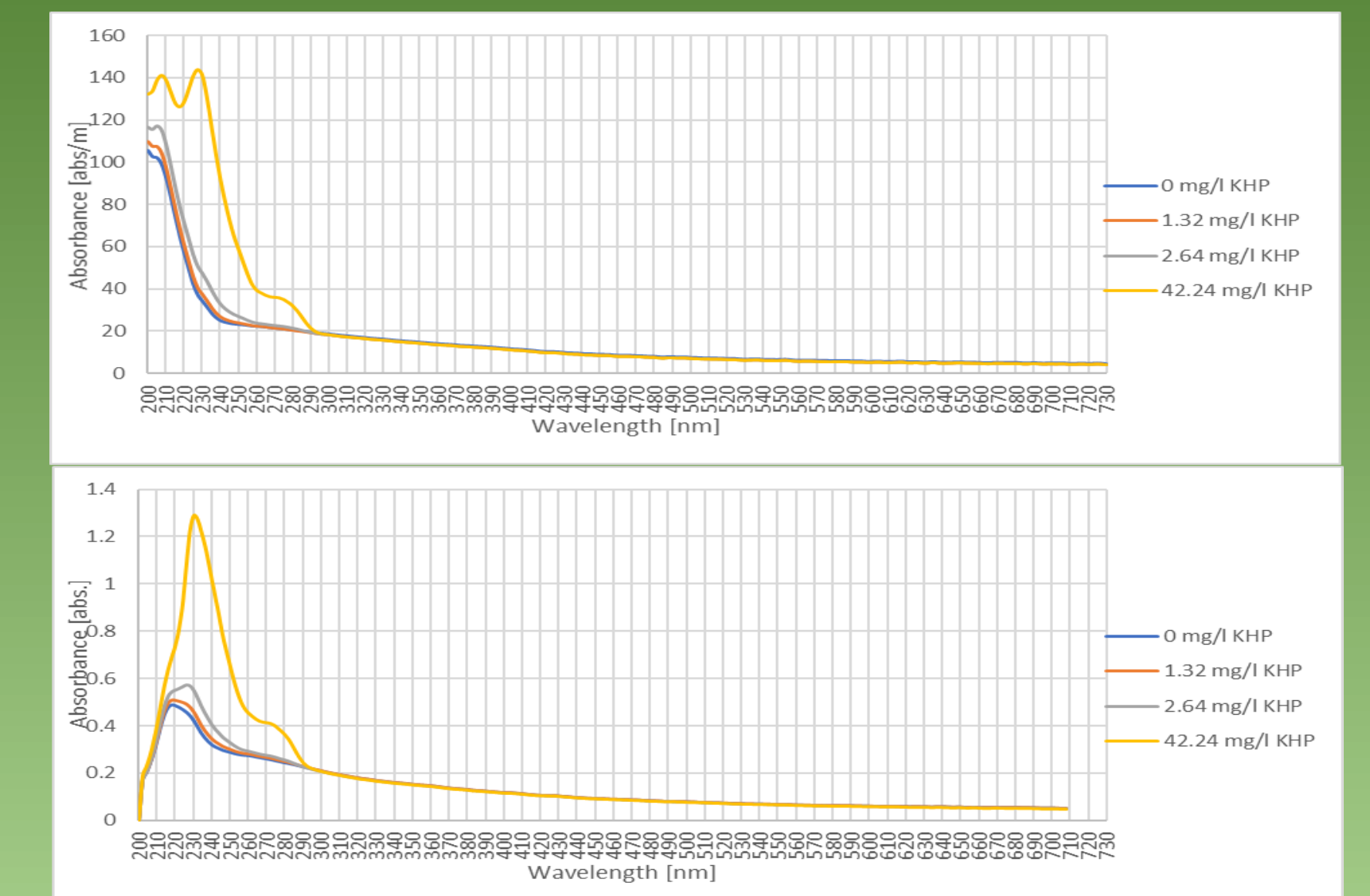


Figure 5: Raw absorbance Values of stream water with added KHP (Top – device A, bottom – Device B). Device A absorbance values are normalized.

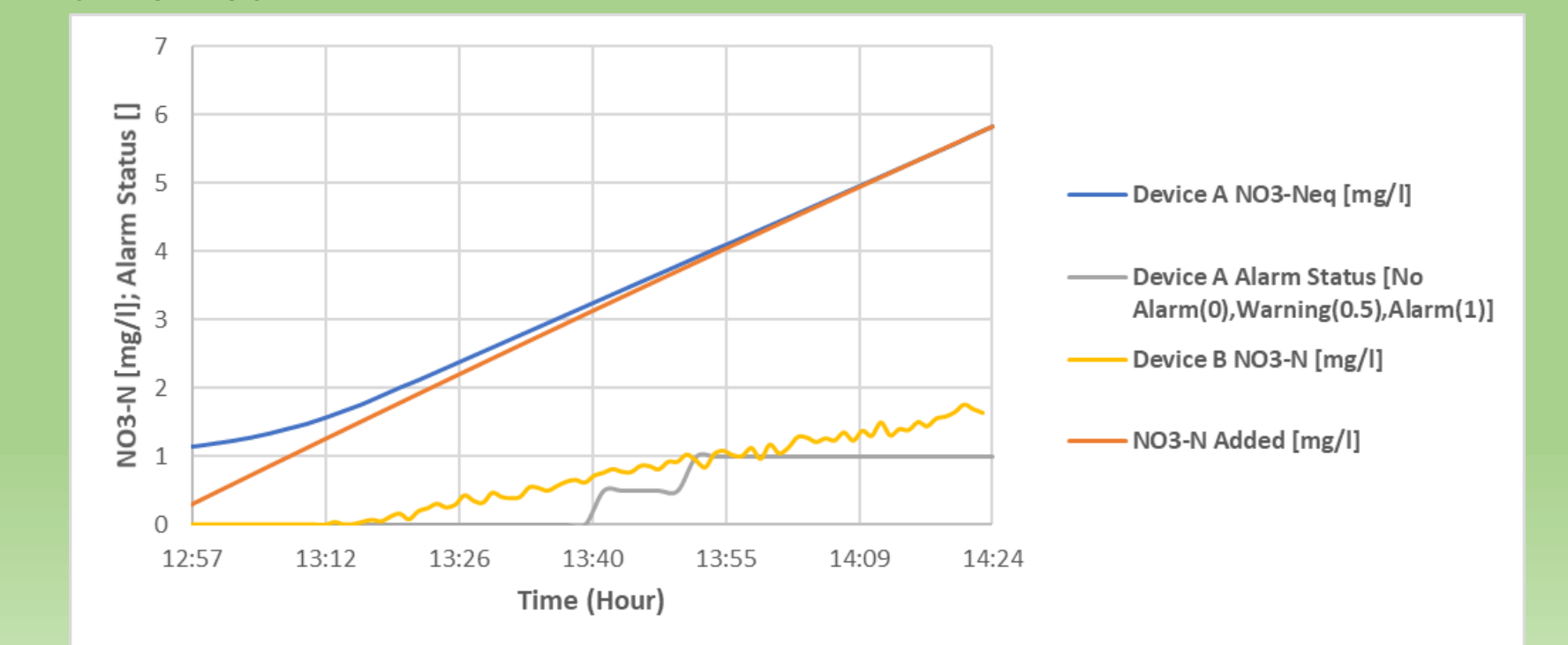


Figure 6: Measured values of NO₃-N calculated by device A (Clean Value) and Device B and device A spectral Alarm Status during field experiment with sodium nitrate (0 - 5.7 mg/l of added NO₃-N).

CONCLUSIONS

The two spectral devices were found suitable for online detection and warning of stream contamination, but there is a certain gap in the amount of resources needed for calibration of the instruments and in the level of expertise required for their maintenance and operation. In the field experiments, significant differences were found in the responses of the two devices to the added pollutants/ simulants. Further along the road, the readings of the chosen spectral device will be added as new layer of the calculation of the water quality index.

SELECTED REFERENCES

- Avagyan, A., Runkle, B., & Kutzbach, L. (2014). *Application of high-resolution spectral absorbance measurements to determine dissolved organic carbon concentration in remote areas*. Journal of hydrology(517), 435-446.
- Jollymore, A., Johnson, M., & Hawthorne, I. (2012). *Submersible UV-Vis spectroscopy for quantifying streamwater organic carbon dynamics: Implementation and challenges before and after forest harvest in a headwater stream*. Sensors(12), 3798-3813.
- Ruhala, S. S. (2017). *Using in-situ optical sensors to study dissolved organic carbon dynamics of streams and watersheds: A review*. Science of the total environment(575), 713-723.
- Van den Broeke, J., Langergraber, G., & Weingartner, A. (2006). *On-line and in-situ UV/vis spectroscopy for multi-parameter measurements: a brief review*. Spectroscopy Europe, 18(4), 18-25.

CONTACT INFORMATION

Eyal Bitkover
Email: eyalbitkover@gmail.com
Mobile: 972-54-8834439